People Saving People

FINAL REGULATORY EVALUATION

National Highway Traffic Safety Administration

46376 NHTSA-98-4662-1

Amendments To School Bus Body Joint Strength FMVSS No. 221

Office of Regulatory Analysis & Evaluation
Plans and Policy
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SUMMARY

Objectives

The agency believes that requiring: (1a) exempted maintenance access panels (MAPs) to be redesigned or (1 b) unexempted MAPs to conform to the 60 percent joint strength requirements; (2) extending the new MAP and joint strength requirements of FMVSS No. 221 to small school buses; and (3) improving the "objectivity" of the standard's compliance requirements, should contribute to reducing or eliminating some of the fatal/serious injuries caused as a consequence of school bus crashes.

Benefits

It is estimated that NHTSA's MAP redesign requirements for large and small school buses will reduce or eliminate 5-36 AIS 1-3 laceration-type injuries per year. It is also estimated that extending the existing FMVSS No. 221 body joint strength requirements to small school buses will reduce or eliminate 1-10 AIS 3 fracture-type injuries per year. Overall, 6-46 minor-to-serious injuries would be reduced or eliminated annually.

Costs

Total Consumer Cost = $8.440 million annually (1996 dollars).

Incremental Consumer Cost = $222 per large school bus (sales-weighted average) and $343 per affected small school bus. This results in a combined sales-weighted average of $241 per school bus.

Effective Date

18 months from the date of publication of the final rule.

I. INTRODUCTION AND BACKGROUND

Investigations of large school bus crashes have demonstrated a propensity for maintenance access panel (MAPs) joints, currently exempted from FMVSS No. 221, to separate and create sharp cutting edges that have injured occupants. In addition, investigations of crashes involving small school buses, currently exempt from FMVSS No. 22 1, have demonstrated a propensity for MAP and interior body joint separations. The subject final rule: (1) defines exempted and unexempted MAPs for large and small buses, (2) extends the requirements of FMVSS No. 221 for body joint strength to small, Type A school buses, and (3) makes improvements to the language of the standard to eliminate ambiguity and improve "objectivity."

In a March 1991 Notice of Proposed Rulemaking (NPRM), NHTSA proposed revisions to Federal Motor Vehicle Safety Standard No. 221, School Bus Body Joint Strength (56 FR 11142; March 15, 1991). The agency proposed: (1) revising the existing exemption for MAPs on school bus bodies, (2) extending the scope of the standard to include all school buses including those with a GVWR of 10,000 lbs. (4,563 Kg.) or less, and (3) enhancing the objectivity and applicability of the school bus joint strength requirements and test procedures. The proposal clarified that the requirements of the standard are applicable to floor joints as well as body joints. In addition, the proposal requested comments on whether the existing joint requirement, which is based upon the relative strength of joined panels, should be revised in favor of a specified minimum absolute strength for school bus body joints.

In June 1987, NHTSA published an Advance Notice of Proposed Rulemaking (ANPRM) on school bus body joint strength issues (52 FR 23315; June 19, 1987). This notice requested comments on 24 questions concerning the exemption of MAPs, revisions to the test procedure and the need for the specification of a minimum integrity requirement for school bus floors.

As amended in 1974, Section 102 of the Vehicle Safety Act required the agency to establish standards for a number of aspects of school bus performance, including interior protection for occupants, floor strength, and the crashworthiness of the school bus body and frame. One of the safety standards which the agency issued in response to that requirement was Standard No. 221, School Bus Body Joint Strength. Standard No. 221 was designed to strengthen school buses so the body panels would not separate at their joints and either become cutting edges that could seriously injure occupants during a crash or permit occupants to be ejected through openings created by the joint separations. MAPs, however, were exempted from the provisions of the standard, as were ventilation panels.

Although implementation of Standard No. 221 substantially reduced the previous safety problem of body panels becoming easily detached in crashes, the agency became concerned that manufacturers were circumventing the standard in some cases by excessive designation of interior panels as MAPs. To address this concern, the agency published an NPRM (49 FR 57939; November 27, 1981), which proposed to remove the exemption for all MAPs, except for a few considered critical for proper maintenance. After considering available information, including comments from the public, school bus manufacturers, and school bus purchasers, the agency eventually terminated the rulemaking proceeding (49 FR 27181; July 2, 1984). Termination was based on the lack of evidence that MAP separations during school bus crashes had actually caused personal injuries.. There was also a concern that if additional fasteners were added to an MAP to achieve the 60 percent joint strength, subsequent maintenance activities by a mechanic, such as MAP replacement with just a minimum number of screws, could potentially create a safety problem.

On May 31, 1985, a large school bus crash occurred in Snow Hill, NC in which a high speed tractor-trailer sheared open the side of the bus, resulting in 5 fatalities and one AIS-3 ejection.[1] The ejection may have been due to floor joint separation. In their report investigating the crash, the National Transportation Safety Board (NTSB) recommended that NHTSA amend or clarify FMVSS No. 221 to: (1) require school bus body structures to be tested in tension or peel, unless they can only be tested in shear, (2) make all body panel joints that enclose the occupant space subject to the standard, and (3) resume testing of school bus floor joints to assure compliance with 221 (NTSB H-86-054, 055 and 056, Class II, Priority Action)[2]

[1]Multiple Vehicle Collision and Fire, U.S. 13 near Snow Hill, North Carolina, May 31, 1985, Highway Accident Report, National Transportation Safety Board, Washington, D.C. 20594, NTSB/HAR-86/02, PB86-916202.

[2]Safety Study: Crashworthiness of Large Post Standard School Buses, National Transportation Safety Board, Washington, D.C. 20594, Report No. PB87-917002, NTSB/SS-87/01.

These recommendations were subsequently superseded by NTSB recommendation H-89-20 (Class II, Priority Action) following the severe Bronson, FL school bus crash in August 1987, in which the collapse of the school bus floor contributed to the death of an 11-year-old boy.[3,4] NTSB recommended that NHTSA: (1) expedite the process of amending FMVSS No. 221 to make clear that all floor joints are subject to the body joint standard, (2) remove the apparent anomaly in S5 which allows the strength of the floor to be 60 percent of the weakest material being joined, and (3) make joint strength compliance tests reflect the types of loads experienced in a crash.

In their March 18, 1987, study, "Safety Study: Crashworthiness of Large Post-Standard School Buses," NTSB found that in 5 of the 43 large school bus crashes studied, MAP separations occurred (Case Nos. 13, 21, 27, 35, 43) causing serious head laceration injuries in two of the cases (No. 13 and 43).[2] Both were severe crashes. For case No. 13, "the joint which the access panel had covered previously was splattered with blood, hair and tissue. This indicates that the sharp edges of the exposed joint caused a head injury to one of the school bus occupants." For case No. 43, "joint separations were noted at the connections

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[3]NTSB Safety Information, SB 89-16/5049A, Dated May 9, 1989 and a Letter from J.L. Kolstad, Chairman, NTSB Board, to D.K. Steed, NHTSA Administrator, Subject: Safety Recommendation H-89-20, Dated June 8, 1989.

Collision of Levy County Florida School Bus and Airdrome Tire Centers, Inc., Truck near Bronson, Florida, August 28, 1987, Highway Accident Report, National Transportation Safety Board, Washington, DC, Report No. NTSB/HAR-89/02, PB89-916202.

joining the left and right maintenance access panels to the interior side walls to the rear a quantity of blood, hair and human tissue was present on the edge of the body panel above the 13th row of seats."[2] NTSB recommended that NHTSA: (1) include interior MAPs in the performance requirements of FMVSS No. 221 and (2) apply the performance requirements of 221 to floor panels and interior MAPs. (See NTSB Recommendations H-87-1 1 and 12, Class II, Priority Action).

In their October 19, 1989 study, "Safety Study: Crashworthiness of Small Post-Standard School Buses," containing 19 small, Type-A and 5 large, Type-B school bus crash investigations, interior joint separations were documented in 5 out of the 19 Type-A school buses studied (14 were van conversions and 5 were cab-chassis types) and 1 out of the 5 Type-B school buses studied. (See Type-A Cases No. 10, 11, 13, 14, 16, and Type-B Case No. 24)[5]

For one of the Type-A school buses (Case No. 13, Houston, Texas, a van conversion), ". .a MAP, on the interior left side just to the rear of the driver's seat, was displaced about 2 inches, posing a potential hazard to passengers." [Although it is believed small school buses are required by law to have FMVSS No. 221 compliant body joints in Texas, it is unknown if the law applied to 1980 model year small school buses. Nonetheless, MAPs would have been

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[5]Safety Study: Crashworthiness of Small Post-Standard School Buses, National Transportation Safety Board, Bureau of Safety Programs, Washington DC, 20594, NTSB/SS-89/02, PB 89-917003, October 11, 1989.

excluded under FMVSS No. 221.] Technically, the GVWR of a small, Type-A school bus is less than or equal to 10,000 lbs. (4,536 Kg.), whereas the GVWR of Types B, C and D (or large) school buses are greater than 10,000 lbs.(4,536 kg.). Both the van conversion and cab-chassis type small school buses have interior MAPs. Small, Type-A school buses are exempt from the school bus body joint provisions of FMVSS No. 221, while Types B, C and D school buses are required to comply. As a result of their small school buses crashworthiness study, NTSB recommended that NHTSA collect and evaluate crash data involving small school buses to ascertain whether they should be required to meet the joint strength requirements of FMVSS No. 221. (See NTSB Recommendation H-89-50, Class II, Priority Action).

In their May, 1989 report entitled "Improving School Bus Safety," the Transportation Research Board (TRB), National Research Council, made a general observation regarding MAPs.[6] TRB stated;

> ".several of the school bus accident cases reviewed involved post-1977 Type I (same as Type B, C and D) buses that apparently sustained severe structural damage with corresponding violation of integrity of the passenger compartment. In some of these crashes (e.g., collisions with the tractor semi-trailers or massive fixed objects) further improvements to the structural integrity of the bus may have been of little or no benefit. In other cases,. making less hazardous those body panels that are now exempt from the provisions of FMVSS No. 221 (e.g., ventilation space, access panels) might have reduced the likelihood of death and severity of injuries sustained."

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[6]Improving School Bus Safety, Special Report 222, Transportation Research Board, National Research Council, 2101 constitution Avenue, N.W., Washington, DC, 20418, May, 1989.

The subject final rule is designed to address the above recommendations issued by the National Transportation Safety Board and the Transportation Research Board.

All new relevant school bus crashes investigated since NTSB published their large (1987) and small (1989) school bus crashworthiness reports were also considered by NHTSA and are discussed below. ["P" designates preliminary information (12.5 percent of the NTSB reports) and "R" designates NTSB report available (87.5 percent of the NTSB reports).]

1. August 28, 1987 Bronson, Florida (R) - A large school bus with 21 passengers traveling at 31 mph was impacted by a medium duty truck at 42 mph. Five students were killed and 16 sustained minor to serious injuries. The bus body separated from the chassis and the front of the bus body was crushed back to the 10th row of seats. The collapse of the bus floor contributed to the death of an 11 year old boy seated in the 4th seat. This was clearly identified by NTSB as a floor joint failure problem.

2. May 14, 1988 Carrollton, Kentucky (R) A yellow church activity bus (a former large, yellow school bus) crash. Sheared sheet metal as well as floor and stepwell body separation could have contributed to the smoke and toxic fumes which flowed into the occupant compartment from the ignited gas tank just below. This in turn caught seat cushions on fire. Due to the extremely high crash forces involved, it is highly unlikely that a more stringent body joint standard could have prevented failure of the body sheet metal or the floor and

stepwell body joints. There were no injuries due to crash forces. No MAP or body joint recommendations were made by NTSB in their report.

3. September 21, 1989 Alton, Texas (R) A large school bus with 81 students was impacted at an intersection by a medium duty tractor-trailer. The school bus traveling at about 30 mph traversed a dirt berm and plunged 24 feet down into a caliche pit (an excavation pit) filled with 10' of water. Twenty-one students drowned. There were 3 serious injuries and 46 minor injuries sustained by student survivors. None of the fatally injured students received crash-related injuries that would have prevented them from escaping from the school bus. There were no MAP or body joint separations identified by NTSB. According to NTSB, ". .the bus generally exhibited good crashworthiness."

4. July 31, 1991 Palm Springs, California (R) A 72 passenger large school bus ran off the road and down an embankment colliding with boulders in a single vehicle, loss-of-control crash. The bus driver and six passengers were killed and 47 passengers were injured. The school bus body was sheared-off and separated from the chassis frame rails. The body remained intact. NTSB's report did not contain any recommendations regarding MAP or joint separations. Under Conclusions and Findings the report states; "...The school bus body performed as intended by FMVSS Nos. 221, 222 and 301."

5. November 10, 1993 Snyder, Oklahoma (R) - A 66,500 lbs. tractor-trailer traveling at approximately 48-52 mph broadsided a small, Type-A school bus. The bus was struck in the

right side behind the right-front entrance door. The folding door may have obstructed the driver's view of traffic. Eight children were not wearing the available lap belts and were ejected: four of the ejected children died and the injuries of the remaining four ranged from minor to serious. The unrestrained bus driver sustained severe injuries. The NTSB report did not contain any recommendations pertaining to MAP or joint separations. Oklahoma is one of 22 states that require, by law, the 221 joint strength option for their small school buses. This was a 1993 model year small school bus so there is a high probability it was 221 compliant.

6. October 25, 1995, Fox River Grove, Illinois (R) A train collided with the rear of a large school bus at a RR crossing. There were 7 fatalities, 24 students sustained serious injuries, and 4 were not injured. The bus body was sheared from the chassis frame rails by a train traveling at 60 -70 mph. The NTSB report does not contain any recommendations pertaining to MAP or joint separations.

7. May 1, 1996 Bonita, Louisiana (P) - AMTRAM Morehouse Parish Public School bus/ RR crossing crash. The driver of the large school bus may not have opened the front door and observed or heard an approaching train. The driver was ejected and seriously injured and one student was injured. Bus drivers are required to stop and listen for any approaching train. NTSB did investigate according to School Transport News (STN), November, 1997 article and made an announcement as to cause; "..sub-standard driver actions." Based on NTSB preliminary finds, there were no MAP or joint separations.

8. August 1996, Flagstaff, Arizona (P) A single vehicle rollover crash involving a large school bus. Vehicle crush forces occurred primarily in the A-pillar area. No MAP or joint separation problems occurred according to NTSB preliminary reports.

9. September 1996, Fond-Du-Lac, Wisconsin (P) -- A tractor-trailer rear-ended a large school bus and crushed a passenger car/station wagon in the process. 4 fatalities in the station wagon and one 15 year old student killed in the school bus. (See article "High School Student Killed as Semi Slams Car and Bus in WI Fog." STN November 1996) Based on preliminary NTSB findings, there were no MAP or body joint separations.

10. December 4, 1996 West Baton Rouge Parish, Louisiana (P) -- Train collided with a large school bus a 1997 GMC/Blue Bird conventional. No children were on-board at the time. Only the driver, wearing a seat belt, received minor injuries. (NTSB investigation SRH-97-F-H001.). Upon impact the school bus rotated counterclockwise off the track, remaining upright, and came to a final rest in a ditch. The fully qualified, well trained, experienced bus driver drove around active RR crossing protection and the bus was struck by the train. Based on preliminary NTSB findings, there were no MAP or body joint separations.

11. April 10, 1997 Monticello, Minnesota (P) -- A large school bus collided with a gravel tractor-trailer combination. Three school children and the truck driver were killed. There were 13 children on-board at the time. Three students and the 24 year old bus driver were treated and released, while 7 students remained hospitalized over night. The driver of the

Barton Sand and Gravel Co. truck failed to yield the right of way and ran a stop sign. Based on preliminary NTSB findings, there were no MAP or body joint separations.

12. October 16, 1997 Franklin, North Carolina - A large activity school bus (white color but conforming to FMVSS No. 221) transporting a girls soccer team was struck by a 16,000 lbs. concrete telephone cable vault which was released inadvertently from the flatbed of an on-coming truck. The roof of the bus was sheared/separated from the bus body. The driver of the bus and one student died in the crash. NTSB is investigating the cause of this crash which is believed to involve tractor-trailer driver alcohol, loss-of-control and excessive speed. It is highly improbable that a more stringent body joint strength standard could have prevented this damage from happening. Other than as noted above, NTSB indicated there were no MAP or joint separations.

13. October 31, 1997 Easton, Maryland (P) -- A large school bus was struck by a tractor-trailer combination truck in foggy conditions. The tractor-trailer was moving at approximately 50 mph. The driver of the bus was killed and about 30 students were hospitalized with 9 remaining over night. This appears to have been a side impact crash at the front of the bus, driver's side (engine-to-engine). The semitrailer swung around and caused some exterior body joint separation at the 10th seating position, near the floor level, at the point of impact with the bus body. NHTSA staff traveled to Easton, MD and inspected the bus interior. They reported that they did not see any MAP or joint separations that could have been injurious to

passengers. Based on preliminary NTSB findings, there were no MAP or body joint separations, other than as noted above. NTSB will investigate this crash further.

Other bus crashes considered for the analysis but rejected were; (1) Detroit, MI school bus crash (11/97) did not meet NTSB selection criteria, (2) Lincolnton, NC (2/17/86) crash involving a 1972 Thomas Built was a pre-standard school bus, (3) Cosmopolis, WA bus crash involved a transit bus, (4) Albuquerque, NM bus crash involved a motor coach, and (5) Holmesville, NY adult activity bus crash (4/5/83) was a non-school bus.

Tables I-1, Summary of MAP Separation Frequency and Injury based on NTSB Investigations and Table I-2, Summary of Interior Body Joint Separation Frequency and Injury based on NTSB Investigations, summarizes 80 NTSB school bus crash investigations occurring since 1984 including MAP and body joint separation frequency, the number and size of the buses involved, source description and related type and number of injuries.

Table I-1
Summary of MA Separat n Frequency and Injury based on NTSB vestigations

Freq. of MAP Separation	Total Buses Studied	Bus Size (L/S)	Description	Injuries
5	43	L	Large School Bus Study by NTSB Cases #13, 21, 27, 35, 43 Serious head lacerations #1 3 & #43*	2 MAP injuries: 1 AIS-3 head laceration 1 AIS-2/3 head laceration*
1	1	L	Palm Springs, CA (bus plunged down an embankment) found MAP separation**	
1	19	S	Small School Bus Study by NTSB #13 had MAP separation.	
0	1	S	Snyder, OK (48-52 mph T-bone) (Equipped with 221 joints)	
0	5	L	Type-B School Buses (from Small School Bus Study by NTSB)	
0	11	L	Remainder of 1987-97 NTSB crash investigations	
Total 7	Total 80			Total 2

The NTSB large school bus report did not state the exact AIS level for either of the two head lacerations due to MAP separations (Case Nos. 13 & 43). They were described as having blood, hair and skin present on the edge of the MAP. Based on the Abbreviated Injury Scale (AIS) a head laceration can range from AIS-1 to AIS-3. An AIS-2 head laceration would be at least 10 cm in width and have subcutaneous matter showing, whereas an AIS-3 head laceration would have allowed excessive loss of blood. The NTSB report did not specify these details.

** NHTSA staff reviewed the Palm Springs, CA crash hard copy file and found a MAP separation, but apparently this was not a source of injury. The NTSB report was also checked. This case demonstrates that interior body joint separations may occur even though they are not reported by NTSB in their Findings or Conclusions.

Table I-2
Summary of Interior Body Joint Separation Frequency and Injury based on NTSB Investigations

Freq. of Joint Separation	Total Buses Studied	Bus Size (L/S)	Description	Injuries
1*	43	L	Large School Bus Study by NTSB: Snow Hill, NC, 4 ejected from side wall opening and possibly 2 from floor opening.	Side wall and floor separations contributed to 6 fatalities.
1	1	L	Bronson, FL (floor joint separation)	Floor separation contributed to death of 11 year old boy.
1	5	L	Small School Bus Study by NTSB Type B (Case #24***) Ceiling Seam separated, exact location unknown.	
4**	20	S	Small School Bus Study by NTSB Type A, Small Bus #10, #11, #14 & #16. (Case #16 Side of bus sheared away & Case #17 Chester City, PA catastrophic collapse. **** Also, total includes Snyder, OK.	AIS-3 multiple leg injuries, open fracture L+R tibia and closed femur fracture. (2 deaths in #17 but relevance unknown)
1	11	L	Remainder of 1987-97 NTSB crash investigations	2 deaths in Franklin, NC case, but relevance unknown.
Total 8	Total 80			4 fatals "possible" and 6 fatals related to joint separations. 2 injuries related

* Snow Hill, NC (Case No. 14) side sheared open and floor separated. ** Includes case No. 16 with side sheared away and Case No. 17 with catastrophic loss of structural integrity. *** Case No. 24 (Flower Hill, NY) "..one ceiling seam separated in two places, the separation was 6 inches long and one-fourth inch wide." NHTSA assumes the seam separation occurred in the passenger compartment. **** In Case No. 17 (Chester County, PA) involved loss of small school bus structural integrity and floor bucking.

II. SCHOOL BUS SAFETY PROBLEM

School buses are the safest form of surface transportation, with about 410,673 public school buses transporting some 24 million pupils approximately 4.014 billion miles annually.[1] On a vehicle-mile basis, there are 0.5 school bus occupant fatalities per hundred million vehicle miles traveled, compared to 1.9 occupant fatalities per hundred million vehicle miles in passenger cars (thus, school buses are 4 times as safe as passenger cars on a per vehicle mile basis.)[5] Since school buses typically carry many more occupants than a passenger car, an even more favorable comparison would be occupant fatalities per-passenger-mile, but the agency lacks the appropriate occupancy data needed to make an accurate calculation.

The largest number of fatal injuries relating to school buses occur outside the bus, when children as pedestrians are struck by another vehicle or by the bus itself -- but not as school bus occupants. The Fatality Analysis Reporting System (FARS 1986-96) indicates an annual average of 10 pedestrian fatalities due to "struck by other vehicle" and 26 due to "struck by school bus," including bus body-type and vehicles used as a bus. (See Traffic Safety Facts 1996 School Buses) To help solve the loading/ unloading zone pedestrian problem, NHTSA promulgated a mandatory stop arm rule May 3, 1991 (effective September 1, 1992), and promulgated a rule upgrading rear view

[1]- School Bus Fleet. 1996 Fact Book Issue, January 1996, Bobit Publications, Executive Office, 2512 Artesia Boulevard, Redondo Beach, CA 90278

mirrors for school buses December 2, 1992 (effective December 2, 1993). Both rules apply to large and small buses.

From 1979-1996 there has been an average of 15 school bus occupant fatalities annually.[2] Of this total, about 7.80 percent are estimated to occur in small school buses. The FARS statistics in Table II-1 refer to school bus body-type and exclude other vehicle types (e.g., non-converted vans) used as school buses. Table II-1 shows that the average annual number of large and small school bus occupant fatalities are 14.2 and 1.3, respectively. It should be noted that the number of fatalities experienced in 1988 and 1989 were greater than average because of the Carrollton, Kentucky and Alton, Texas school bus crashes.[3,4]

Table II-2 contains estimates of the annual number of fatal crashes, injury crashes and property damage only (PDO only) crashes for school buses, based on FARS and NHTSA's National Automotive Sampling System (NASS), General Estimates System (GES). The

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NHTSA's 1979-1996 FARS data base and Traffic Safety Facts 1996 School Buses, Fatalities in School-Bus Related Crashes 1986-1996 (Table 5), NCSA, Research and Development, NHTSA, 400 7th Street SW Washington, DC, 20590.

[3]Pickup Truck/Church Activity Bus Head-on Collision and Fire near Carrollton Kentucky, May 14, , 1988, National Transportation Safety Board, Washington, D.C., Report No. PB89-916201, NTSB/HAR-89/01.

[4]Collision between Mission Consolidated Independent School District School Bus and Valley Coca-Cola Bottling Company, Inc. Tractor-Semitrailer, Intersection of Bryan Road and Texas Farm-to-Market Road 676, Alton, TX, September 21, 1989, National Transportation Safety Board, Washington, DC, Report No. PB90-916202, NTSB/HAB-90/02.

estimates have sampling errors associated with them as shown in the Appendix.

Unfortunately, it was not possible to accurately distinguish between large and small buses in these files in NASS/GES.[5]

Table II-1
Large and Small School Bus Fatalities by Year (FARS)

Year	Large	Small	Total
1979	16	1	17
1980	11	3	14
1981	12	0	12
1982	9	0	9
1983	17	0	17
1984	20	0	20
1985	24	0	24
1986	2	0	2
1987	12	2	14
1988	36	2	38
1989	33	0	33
1990	12	1	13
1991	8	2	10
1992	6	1	7
1993	5	5	10
1994	1	1	2
1995	16	2	18
1996	18	0	18
Avg.	14.2	1.3	15.5
Percentage	92.2%	7.8%	100%

* Small bus is defined as less than or equal to 10,000 lbs. (4,536 Kg.) GVWR and a large school bus is defined as being greater than 10,000 lbs. (4,536 Kg.) GVWR.

The primary data source for NASS/GES is the Police Accident Report (PAR). Due to the lack of information provided on the PAR concerning school buses, there is no definitive way to distinguish between small and large school buses. For the majority of vehicles coded as school buses, the VIN is missing and the size of the school bus is not indicated elsewhere on the PAR.

Table II-2

MOTOR VEHICLE TRAFFIC CRASHES INVOLVING SCHOOL BUSES (BODY TYPE)
BY FIRST HARMFUL EVENT AND CRASH SEVERITY
FARS/GES 1996

	CRASH SEVERITY			
	FATAL CRASH	INJURY CRASH	PROPERTY DAMAGE ONLY CRASH	TOTAL
FIRST HARMFUL EVENT				
COLLISION WITH MOTOR VEHICLE IN TRANSPORT	101	5.000	18.000	23,000
COLLISION WITH FIXED OBJECT	2	*	*	*
COLLISION WITH OBJECT NOT FIXED	26	1,000	3,000	3,000
NON-COLLISION	6	.	*	*
TOTAL	135	6,000	21,000	27,000

Table II-3

PERSONS KILLED OR INJURED IN CRASHES INVOLVING SCHOOL BUSES (BODY TYPE)
FARS/GES-1996

	INJURY SEVERITY		
	FATALITY	INJURED	TOTAL
PTYPE			
BUS OCCUPANT	18	8,000	8,000
OTHERS	142	*	•
[illegible]	160	8,000	9,000

* Sample size was too small to produce a meaningful estimate. The estimate was less than 500.

GES estimates have been rounded to the nearest thousand. The overall totals may not be equivalent to the sum of the individual cells due to individual cell rounding.

Based on 1996 FARS and NASS-GES data, Table II-2 shows that about 135 fatal school bus crashes, about 6,000 injury crashes and about 21,000 PDO only school bus crashes occurred. Table II-3 shows that, based on 1996 FARS and NASS-GES data, about 8,000 school bus occupant injuries were produced in the 6,000 injury crashes.[6] (See the Appendix for the standard errors applicable to Tables II-2 and II-3.)

Table II-4 contains national estimates of the average annual number and percentage of school bus occupant injuries by AIS level. Based on 1988-1996 NASS-GES, it is estimated that there are an average of 9,556 occupant injuries per year in school bus crashes.

For comparison purposes, estimates from the National Safety Council (NSC) for the 1995-1996 school year, 71.4 percent (22,000/30,800) of school bus crashes (both large and small) are property damage only (PDO) crashes, while 28.6 percent (8,800/30,800) of the school bus crashes produce injuries and/or fatalities. The NSC estimates that the non-PDO crashes resulted in about 13,000 total school bus occupant injuries in 1996.

F<u>ARS/General Estimate System 1996</u>, A Review of Information on Police-Reported Traffic Crashes in the United States, NHTSA/NCSA, U.S. Department of Transportation,

Table II-4
Average Annual Number of School Bus Occupant Injuries by AIS Level
for Drivers and Pupils
(Large and Small School Bus Crashes Combined)

Abbrev. Injury Scale	Driver	Pupil	Total	(Percent)
AIS-0 (No Injury)			22,649	(70.33)
AIS-1 (Minor)	875	7,285	8,160	(25.33)
AIS-2 (Moderate)	104	885	989	(3.07)
AIS-3 (Serious)	33	295	328	(1.02)
AIS-4 (Severe)	4	38	42	(0.13)
AIS-5 (Critical)	2	18	20	(0.062)
AIS-6 (Fatal)			17	(0.053)
Total			32,205	(100.0)

1988-1996 NASS-GES (S. Partyka)
Total number unweighted crash cases = 1,686
Total number unweighted cases per year = 187

NHTSA derived rough estimates of the number of small school buses in-use, and has roughly estimated the number of small school bus crashes and injuries occurring annually. The agency estimates that about 16-25 percent of the school bus in-use population or 65,708 to 102,668 units [(.16 X 410,673) to (.25 X 410,673)] are small, Type-A school buses and that annual sales average 16 percent of 35,000 units, or about 5,600 buses per year (.16 X 35,000 = 5,600). The upper boundary of 25 percent for small buses in-use was derived from <u>1993 School Bus Fleet</u> data as shown in the Appendix. Employing Tables II-2 and II-3 and assuming that crashes and injuries are proportional to the small school bus population (16-25 percent of the total), the agency estimates there are 1,280-2,000 [(.16 X 8,000) to (.25 X

8,000)] small school bus occupant injuries annually and 4,320-6,750 [(.16 X 27,000) to (.25 X 27,000)] small school bus crashes annually.

Table II-5 shows the number and percentage of injuries for both large and small school buses based on the moderate to severe crashes investigated by NTSB in their 1987 and 1989 aggregated school bus crashworthiness studies. For the 1,119 occupants in the large buses, 597 (53 percent) were injured, whereas for the 144 occupants in small buses, 108 (75 percent) were injured. Comparing the proportion of AIS-0 level (no injury) based on Table II-4 and Table II-5, for all school bus crashes, 70 percent had no injury whereas in the NTSB sample, only 46 percent (large) and 25 percent (small) had no injuries. Similarly, as a relative ranking of crash severity based on Table II-4 and Table II-5, for all school bus crashes 27 percent had injuries whereas in the NTSB sample, 54 percent (large) and 75 percent (small) had injuries. Assuming the same NTSB sampling stratification as large school buses, small school bus occupants appear to sustain a higher proportion of injuries in a given crash. Clearly, the NTSB cases have a higher proportion of more severe injuries as expected. The NTSB cases represent a stratified sample consisting of moderate to severe school bus crashes selected according to specific criteria (e.g., school bus was disabled or rolled over or an occupant was killed or sustained an incapacitating injury). The reader is cautioned against comparing injury rates or making national projections from the data in Table II-5.

Table II-5
Summary of Large and Small Bus Injury Data
(based on NTSB's Crash Investigations)

	Large Buses (n=43)		Small Buses (n=19)	
	Number	Percent of Total	Number	Percent of Total
Uninjured	522	46.45	36	25.00
AIS-1	483	43.16	87	60.42
AIS-2	58	5.18	12	8.33
AIS-3	24	2.14	7	4.86
AIS-4	10	0.89		
AIS-5	5	0.45	2	1.39
AIS-6	2	0.178		
Unknown	15	1.34		
Fatalities	15*		2*	
Total Occupants	1,119		144	

* These fatalities are already included in the above AIS distribution.

NTSB Crashes as a Percentage of All School Bus Crashes

NHTSA estimates that the NTSB investigated school bus crashes represent about 1 to 6.4 percent of all school buses crashes nationwide. NTSB generally investigates moderate -to-severe crashes. Using NASS-GES 1988-1996, the agency estimated two sub-populations of school bus crashes [(1) A or K or rollover (2,216 weighted crash count) and (2) A or K or rollover or towed away (14,147 weighted crash count))] which most closely approximated the NTSB selection criteria. [A = occupant with incapacitating injury and K = occupant killed.] Crashes included in multiple categories were only counted once. The NTSB selection criteria as described in their large and small school bus studies were; (1) bus disabled, or (2) bus rolled over or (3) occupant killed or occupant had an incapacitating injury. The total number of school bus crashes for the 9 years was 221,009 (weighted count). Due to the uncertainty as to which of the above NASS-GES data runs best approximates the sub-population of school bus crashes selected by NTSB, NHTSA has chosen a range for purposes of analysis, namely 1.0 to 6.4 percent [((2,216/221,009) X 100%) to ((14,147/221,009) X 100%)].[7] The weighted counts represent 9 years of data and the weighted/unweighted crash counts are shown in the Appendix.

MAP and Body Joint Separation Rates

Referring to Table I-1, and based on the investigation of 80 school bus crashes by NTSB, the measured MAP separation frequency is 8.75 percent (7/80). Based on the 1988-96 NASS-GES file, about 1.0 to 6.4 percent of all school bus crashes annually meet the NTSB school bus crash selection criteria (e.g., bus disabled, bus rolled over, or occupant killed or incapacitating injury). Therefore, it is estimated that MAP separations occur annually in 0.087-0.56 percent [(.0875 X .010) - (.0875 X .064] of all school bus crashes. Referring to Table I-2, and based on the investigation of 80 school bus crashes, the measured interior body joint separation frequency was 10 percent (8/80). This implies that interior body joint separations occur in about 0.10-0.64 percent [(.100 X .010) (.100 X .064)] of all school bus

The 1.0 percent figure represents categories (2) or (3) above, the bus rolled over or incapacitating or fatal injury. The 6.4 percent figure represents categories (1), (2) or (3) above including bus disabled.

crashes. The above frequencies include all crashes regardless of how catastrophic. These are quantified more definitively in Chapter IV, Benefits.

It is NHTSA's opinion that this small magnitude of need does not justify including all interior MAPs in the joint strength requirement with the attendant risk of reducing the quality of maintenance and reliability of systems necessary for operational safety. However, NHTSA believes that the NTSB data does justify attempting to minimize the number of exempted joints, especially where there tends to be an abuse or the unnecessary extension of oversize panels. In their comments, the Virginia Department of Education (VA-DOE) noted "..that access panels exceed the size necessary to perform routine maintenance and should be re-designed."

Relevant Cases - MAP/Body Joint Separation

As noted in Chapter IV, Benefits, NHTSA eliminated some school bus crashes from further consideration as they were catastrophic in nature and probably not amenable to the countermeasures of the subject final rule. NHTSA determined that 6 large school bus cases (2 involving injuries) and 1 small school bus MAP separation case (involving no injury) could be improved by the subject rule. Relative to body joint separations, the two large school bus cases (Snow Hill, NC and Bronson, FL) with floor separations would not be amenable to the final rule as the Thomas Built Bus floor joint welding problem was corrected many years ago in 1989. The agency assumes the one small school bus (Case No. 16) with side wall separation and AIS-3 leg injuries would be amenable to improvement based on the subject rule.

It should be noted that the crashworthiness requirements of large and small buses differ in two substantial areas: (1) lap belts and (2) body joint strength. Large school bus crash protection emphasizes "compartmentalization" consisting of seat back padding, 20 inch (50.8 cm) high seat backs, regulated seat spacing and stronger floor supports and seat frames, for occupant protection compared to small buses. Also, padded restraining barriers are required near the front door and behind the driver. On the other hand, the primary means of crash protection for small school buses consists of lap belts, which must comply with FMVSS Nos. 208, 209 and 210 and padded seat backs. The seating performance requirements (S5.1.2 through S5.1.5 for FMVSS No. 222) are the same for small and large buses. Small school buses are not required to have restraining barriers. Although large and small buses must comply with FMVSS Nos. 217 and 301, small buses have been exempt from FMVSS No. 221. In addition, because small buses are built on light truck and van (LTV) chassis, the bus driver compartment area, in particular, would also meet FMVSS Nos. 204, 212, and 219 at 30 mph, as well as most LTV crash avoidance requirements.

Small, Type-A school buses typically consist of a lap joint, steel body built on a van cab-chassis or incomplete chassis [< = 10,000 lbs. (4,536 Kg.) GVWR] purchased from GMC, Ford, or Chevrolet. Buses (< = 10,000 lbs. (4,536 Kg. GVWR) are subject to the dynamic crash test requirements of FMVSS No. 208 and after model year 1999 buses < = 8,500 lbs.

(3,857 Kg.) GVWR will be required to have a driver air bag. This means that the chassis, and other attendant components, upon which small buses are built are being dynamically tested. This rule will increase the structural integrity of the bus body even more.

III. SUMMARY OF RULEMAKING ACTION

A. Summary of NPRM

The March 15, 1991, NPRM proposed to: (1) redefine MAPs which are exempt from the provisions of FMVSS No. 221; (2) extend the MAP and joint strength requirements of 221 to small, Type A buses; and (3) improve the "objectivity" of the joint strength standard.

A.1 Redefinition of Exempt MAPs - The intended effect of NHTSA's proposal was to continue to exempt from the 60 percent joint strength requirement certain MAPs such as exterior and forward interior panels which are outside the zone of likely passenger contact or defined "passenger compartment." Compliance with S5 (e.g., joint strength must be 60 percent of weakest member) would be required if a panel(s); (1) opened the floor or firewall exposing the engine or its compartments, (2) are likely to come into contact with passengers during a crash, or (3) exceeds the proposed MAP size restrictions. The proposed revision to the MAP exemption was also intended to make it more likely that all panel fasteners would be replaced following maintenance/repair.

The agency proposed a limited exclusion from the joint strength requirements for necessary MAPs. This was accomplished by providing a specific definition for the term "maintenance access panel" and specifying the circumstances in which MAPs would be required to comply with the joint strength requirements of S5. The agency proposed to retain the exclusion from the joint strength requirement for those access panels which legitimately control access to "serviceable components" that must be accessed on a routine basis (one year or less) and which must meet a new aperture size limit. However, it would terminate the exclusion of panels which simply cover expanses of wires, wire harnesses or tubing which do not need routine maintenance.

Under S4, NHTSA proposed to define "maintenance access panel" as a body panel whose removal and replacement is necessary for routine maintenance of "serviceable component" which is recommended by the chassis or body manufacturer to be performed at intervals of one year or less. A "serviceable component" was defined as part of the bus which is explicitly identified by the bus body or chassis manufacturer in the owner's manuals as requiring routine maintenance at least once each year. However, the definitions would exclude any body panel that provides access only to segments of tubing, wiring, or wiring harnesses, including hose connections or electrical terminals, unless defined to be serviceable components by the manufacturer.

For an MAP to be exempted, NHTSA proposed a 2 inch (5 cm) access margin (or clearance opening) on each side when measured around the periphery of the serviceable component or clusters of components in order to accommodate handling and tool clearance during installation, replacement, inspection, and adjustment procedures. The average spacing between components within a cluster covered by a single exempted panel was not to exceed 2 inches (5 cm) per side of the component. For MAPs, the manufacturers would be required to comply with either S5 or the above size restrictions.

Under S5.4(a) NHTSA proposed requiring compliance with S5 for all MAPs which, when opened or removed, exposed the bus interior to areas below the floor, to the engine compartment, or to compartments adjoining the engine compartment.

NHTSA proposed that the MAP inclusions/exclusions apply in the "passenger compartment" meaning the space "which lies rearward of a vertical transverse plane that is 30 inches (76 cm) in front of the foremost passenger seating reference point as defined by S571.222 (Standard No. 222, School Bus Passenger Seating and Crash Protection).

In addition, all panels subject to S5 would also be subject to the revised test procedures in S6.

A.2 Extend FMVSS No. 221 to Small, Type-A School Buses - NHTSA proposed extending the joint strength requirements (including new MAP requirements) of FMVSS No. 221 to small, Type A school buses with GVWR of < = 10,000 lbs. (4,536 kg.) GVWR. NHTSA's proposal in this area was based on NTSB's findings.

A.3 Improve the "Objectivity" of the Standard - NHTSA proposed that: (1) the standard be amended to incorporate minimum absolute joint strength requirements, (2) trim, decorative parts, floor coverings, molding strips, ventilation panels be subject to the standard, and (3) revisions be made to the test procedure. The proposed test procedure revisions included:

a. clarifying that FMVSS No. 221 applies to each possible 8 inch joint segment, including floor joints, rather than representative segments,

b. defining a new rectangular sample size to improve the number of joints that can be tested (currently constrained by size and location limitations),

c. testing of curved, complex joints to improve the number of joint types that can be tested,

d. defining the method of determining component tensile strength, and

e. quantifying the term "approximately perpendicular."

B. Summary of Comments

B.1 Redefinition of Exempt MAPs - Although the commenters were generally supportive of NHTSA's MAP proposal, they were concerned that the aperture size (a 2-inch (5 cm) periphery access margin around a serviceable component) for exempted MAPs may be too small and that requiring unexempted MAPs to meet 60 percent joint strength would discourage proper maintenance/repair activities.

The Superintendent of Public Instruction, Olympia, Washington (WA) was concerned that the existing MAP exemptions may compromise safety and structural integrity of school buses and agreed that NTSB's concern regarding loose MAPs appears to be well taken care of with NHTSA's proposed revisions. Also, protecting the passenger compartment from possible fires was an important concern to them.

The National Truck Equipment Association, Manufacturers Council of Small School Buses (NTEA/MCSSB) was concerned that the "proposed 2-inch (5 cm) periphery MAP access margin (no more than 4 inches (10 cm) greater than the serviceable component) is not feasible, even in small school buses." They refer to New York which employs a 10" X 20" MAP near front and rear illuminated school bus signs and an 8" X 16" MAP near the front bulk head for access to circuit breakers, fuses, and relays. NTEA/MCSSB further indicated that if the standard is "too restrictive and access made difficult for maintenance personnel, it could result in improper reinstallation of access panels," thus negating safety benefits.

Thomas Built Buses, Inc. (Thomas Built) believes that "the definition of what space is required for access to serviceable components is unrealistic. As anyone that has worked on a car, truck, or bus knows, there is never enough clearance to remove/install the component with which you're working."

Mid Bus, Inc. (Mid Bus) commented that "...inclusion of maintenance panels into the joint strength requirement is seen by us as a detriment to safety." They are concerned that efforts by states to retrofit older buses with new safety equipment may be impeded by the new MAP requirements. "If all these maintenance panels are fastened to 60 percent, the retrofit cost will be greatly increased." However, they concur that some manufacturers have taken liberties with these panels. They believe that MAPs should be restricted in size and feel a reasonable opening would be 144 square inches (929 cm^2), which is greater than NHTSA's proposal.

The National School Transportation Association (NSTA) indicated that the 2 inch (5 cm) area around serviceable components is too small. They are concerned that too many restrictions on

MAPs will result in poorer maintenance on these vehicles. "NSTA does not believe that enough consideration has been given to the safety consequences of maintenance/repairs that will be postponed or avoided due to elimination of almost all access panels." They believe that mechanics will replace only as many fasteners as are required to hold the panel in place after maintenance. Also, they stated that NHTSA ignored added maintenance costs.

The California Highway Patrol (CHP) indicated that they "support the proposal to amend FMVSS No. 221 to provide definitions for previously undefined terms, and to place restrictions on the size and location of maintenance access panels in school buses." The CHP also noted the use of large plastic MAPs in some school buses which are used to cover electrical connections as well as for storage purposes employ "light-duty latches, which do not have positive latching mechanisms." (Note: The agency believes these MAPs are typically used in Type-A school buses, but are located outside the "passenger compartment" as defined in the final rule.)

Blue Bird Body Company (Blue Bird) commented that the agency should focus on MAPs in the rear and side areas above the windows where contact is most likely and not seek to eliminate MAPs that are legitimately needed. They note there are a large number of components on the front (interior or exterior) of the bus which require "quick and easy" access in order to allow safe operation of the bus, and which typically involve chassis manufacturer supplied components and sheet metal for vehicles that are manufactured in two or more stages. They stated, ". .chassis manufacturers may be unwilling or unable to provide access panels conforming with the proposed requirements." Blue Bird recommended against the bus floor and engine compartment MAPs meeting FMVSS No. 221 joint strength requirements. Similar to NSTA, Blue Bird believes that a 60 percent joint strength requirement for floor and/or engine compartment MAPs (S5.4 (a) will do little to "protect the interior of the bus from fire." Blue Bird supported NHTSA's proposed S5.4(b) - joint strength would apply to MAPs in the passenger compartment per the NPRM's definition. Blue Bird also urged NHTSA to consider ways to require or encourage panel fastener replacement as well as consider the advantages of the use of "non-metallic, non-hostile" materials for MAPs, particularly above windows.

American Transportation Corporation (ATC) stated that trim and decorative parts need to be exempted from the standard and that NHTSA made no distinction between metallic and non-metallic parts. ATC stated that MAPs will require more time for removal and replacement, which will increase maintenance cost.

Navistar International Transportation Corporation (Navistar) commented that interior engine covers provide access to a number of critical items that may need to be checked on a daily basis and must be readily accessible during inspection, service, and maintenance activities. These are particularly prevalent in the front of small school buses and rear of transit style buses. For this reason, it is imperative that interior engine access covers be excluded from the FMVSS No. 221 joint strength requirements of S5.

<u>B.2 Extend FMVSS No. 221 to Small School Buses</u> The bus manufacturers were opposed to extending the requirements of FMVSS No. 221 to small school buses. Collins Bus Corporation (Collins) stated:

> "the effect on small school bus manufacturers of these proposed regulations is significant. Small buses are going from no joint strength requirements to full regulation. Small school bus manufacturers will go from no joint analysis to complete joint analysis, along with associated quality control testing programs to substantiate the status of joint strength."

Blue Bird stated "they do not believe there is sufficient safety need nor cost/benefit justification for extending FMVSS No. 221 to cover all school buses." In addition, they were concerned that the agency had not defined what to do with MAPs which are partially within and partially beyond 30 inches forward of the foremost passenger seating point.

The NTEA/MCSSB, stated that they are "not aware of additional data which would warrant extension of FMVSS No. 221 to small school buses." NTEA/MCSSB was concerned that if the body and chassis were required to comply with FMVSS No. 22 1, the incomplete chassis manufacturers (i.e., Ford, GMC, Chevrolet, etc.) would not provide "a compliance statement" supporting pass-through certification. According to NTEA/MCSSB, the school bus manufacturers would have to undertake compliance testing and this would be cost prohibitive (assuming no chassis modifications). They indicated that:

> ". if it becomes apparent that chassis modifications are likely by the small school bus builder, the chassis manufacturer would probably prohibit completion of these chassis into school buses. In this case small businesses would be closed since their main product line is small school buses."

Collins Industries, Inc. (Collins) stated that if joint strength requirements are determined to be necessary, it should only be those that "might lacerate students during a collision" due to contact within the head and knee protection zones defined under FMVSS No. 222. They indicated that safety belt use would keep children away from potentially lacerating panels and sharp edges of exposed interior joints One of the primary means of occupant protection on small school buses is the lap belt. Therefore, they argued that 60 percent MAP joint strength was not necessary. NHTSA does not have any nationally representative belt use statistics for small school buses. From the NTSB studies, driver belt use was 75 percent and passenger belt use was 66 percent for small school buses. For some New York school districts with mandatory belt use policies on school buses, it is known that usage can be as low as 25 percent. Therefore, in response to Collins' comment; (1) lap belt use may never achieve 100 percent leaving some portion of students vulnerable to MAP separation, and (2) there may be a crash scenario where the side wall of a bus caves in and the MAP drops down striking a belted passenger. MAPs can be at shoulder height, the foot area, or overhead. It depends on proximity to children in some cases. In others, cave-in or intrusion might occur.

General Motors Corporation (GM) recommended that the agency collect and analyze more small school bus data before proceeding. They noted that their position was consistent with NTSB's. GM stated it was not clear that the NTSB cases weren't FMVSS No. 221 complying joints, and it was not clear that FMVSS No. 221 joints would have worked. [NHTSA reviewed the NTSB hard copy files of the subject 19 small school bus crashes, and based on observed rivet spacing from each files photographs, believes there is a high probability that these buses did not have 221 compliant joints. As discussed in Chapter V, COST (Table V-3) of this report, there are 22 states that in recent years passed laws requiring the small school buses in their respective states to comply with FMVSS No. 221. Of the 19 NTSB small school buses cases studied, 2 were from Oregon and Texas involving 1979-1982 model year buses. It is highly unlikely that buses of this vintage would have been affected by these recent state laws. Of the 6 small school cases with MAP or body joint separation problems under consideration, one was from the Texas and was a model year 1980 small school bus. On the other hand, the Snyder, Oklahoma case involved a 1993 model year small school bus and there is a high probability that it would have complied with Oklahoma's recent law that small school buses comply with FMVSS No. 221 school bus body joints.]

Ford Motor Company (Ford) was concerned that the FMVSS No. 221 modifications needed to their low-volume Econoline van (which is sold as an incomplete vehicle to make small school buses), might impose substantial costs. Substantial costs would accrue if the incomplete low-volume chassis was different from the high volume Econoline chassis.

American Transportation Corporation (ATC) noted that they were aware of two chassis manufacturers (GM and Ford) who supply the majority of the chassis used for Type-A school buses. Neither of these manufacturers to their knowledge certify that the cab-chassis portion or that the floor meets FMVSS No. 221. Unless GM or Ford will agree to certify the chassis portion as meeting FMVSS No. 221, the body builder or original vehicle manufacturer (e.g., Mid Bus, Collins, etc.) will not be able to offer the van cab-chassis type school bus as built today. ATC indicated that areas where the body panels mate the existing chassis will be difficult to certify to FMVSS No. 221. The proposed rule will have major effects on the school bus industry including body and chassis manufacturers.

Thomas Built believes that body joint strength should be the same for all size buses, because "smaller vehicles receive much higher g loads.. due to the inequality of weight in most crashes." They note that the "body manufacturer cannot effect a change in the chassis manufacturer's joint construction, and the areas where the body meets with the chassis structure can not, in many instances, be made into a 60 percent joint by any practical procedures."

The Maryland State Department of Education (MD-DOE), the California State Department of Education (CA-DOE), the West Virginia Association for Pupil Transportation (WVAPT), the West Virginia Department of Transportation (WV-DOT), WA and the Connecticut Department of Motor Vehicles (CT-DMV) supported NHTSA's small bus proposal.

<u>B.3 Improve the "Objectivity" of the Standard</u> - A number of commenters (MD-DOE, CA-DOE, WA, Thomas Built, CT-DMV, Ford, and the National Association of State Directors of Pupil Transportation Services (NASDPTS) were in favor of specifying an absolute minimum joint strength requirement, whereas Collins and NTEA/MCSSB were opposed. Thomas Built commented that most manufacturers already certify to 60 percent joint strength using 20 gauge exterior and 22 gauge interior steel panels with 45,000 psi minimum tensile strength. Thomas

Built noted that this has provided excellent protection in catastrophic crashes. WA and CA-DOE, and NASDPTS supported 18 and 20 gauge steel for exterior and interior panels, respectively. The National Standards Committee, 12th National Conference on School Transportation (held in Warrensburg, Missouri in May, 1995) recommended relative to panel strength; ". .construction shall be of prime commercial quality steel or other metal, or material with strength at least equivalent to all-steel, as certified by the bus body manufacturer." Ford suggested that NHTSA allow a minimum strength requirement as an "optional" alternative to the existing 60 percent requirement. Collins was concerned the "the rapid march of plastic and composite materials will be unnecessarily impeded if joint strength is set at some magic minimum number." NTEA/MCSSB commented that ". .to set a minimum value based on specific material specifications would restrict future developments."

The commenters were generally opposed to including "spaces designed for ventilation," decorative parts, floor covering/molding strips and/or trim, in the FMVSS No. 221 standard, because these areas are generally non-structural in nature, many are made of non-metallic parts (e.g., fiberglass or other plastic), and many are not in the head contact zone.

The overall summary of comments on the test procedure proposal (in order as discussed above) is as follows: (a) no issues were raised with regard to the applicability of FMVSS No. 221 to each 8 inch joint segment, including floor joints; (b) the commenters were unanimously opposed to changing the specimen size used for tensile testing because it was not practical; (c) the commenters were unanimously opposed to the testing of curved, complex joints, because it was not practical; (d) they supported the proposed method of determining component tensile strength; (e) they supported quantification of the term "approximately perpendicular"; and (f) supported clarifying the procedure for cutting specimens relative to intermittent seam or bead welds. In addition, several commenters were concerned about the applicability of FMVSS No. 22 1 to perforated steel and non-metallic materials.

C. Summary of Final Rule

C. 1(a) Redefined and Exempted MAPs - A number (7/80 = .0875) of school bus crashes have been documented by NTSB in which MAPs separations occurred (large bus study Cases Nos. 13, 21, 27, 35, and 43), Case #13 (Houston, Texas) from small school bus study and Palm Springs, California.[1] In two of the large bus cases (No. 13 and No. 43) head lacerations directly related to the MAP separations were documented.[2] For the Houston, Texas and Palm Springs crashes, it appears as though the MAP separations did not cause injury. Recognizing that the NTSB data is not nationally representative, but rather a stratified sample

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[1] Highway Accident Report: Mayflower Contract Services, Inc. Tour Bus Plunge From Tramway Road and Overturn Crash Near Palm Springs, California, July 3 1, 1991, National Transportation Safety Board, Major Highway Investigations, Washington, DC 20594, Adopted April 13, 1993, NTSB/HAR-93/01, PB-916201 and Photolog: Tramway Road, Surface Marks, and Final Rest Positions of Bus Components at Accident Site, NTSB Exhibit No. C-3, Docket No. HY-525-91.

[2] For large school bus cases #13 and #43, where head lacerations occurred with MAP separation, NTSB indicated Maximum AIS (MAIS) which included a head concussion, head laceration, ulna fracture, etc. The exact head laceration injury level was not specified. A head laceration injury can range from AIS 1 to AIS 3. For an AIS-2 the cut is at least 10 cm long with subcutaneous matter showing and an AIS-3 requires excessive loss of blood.

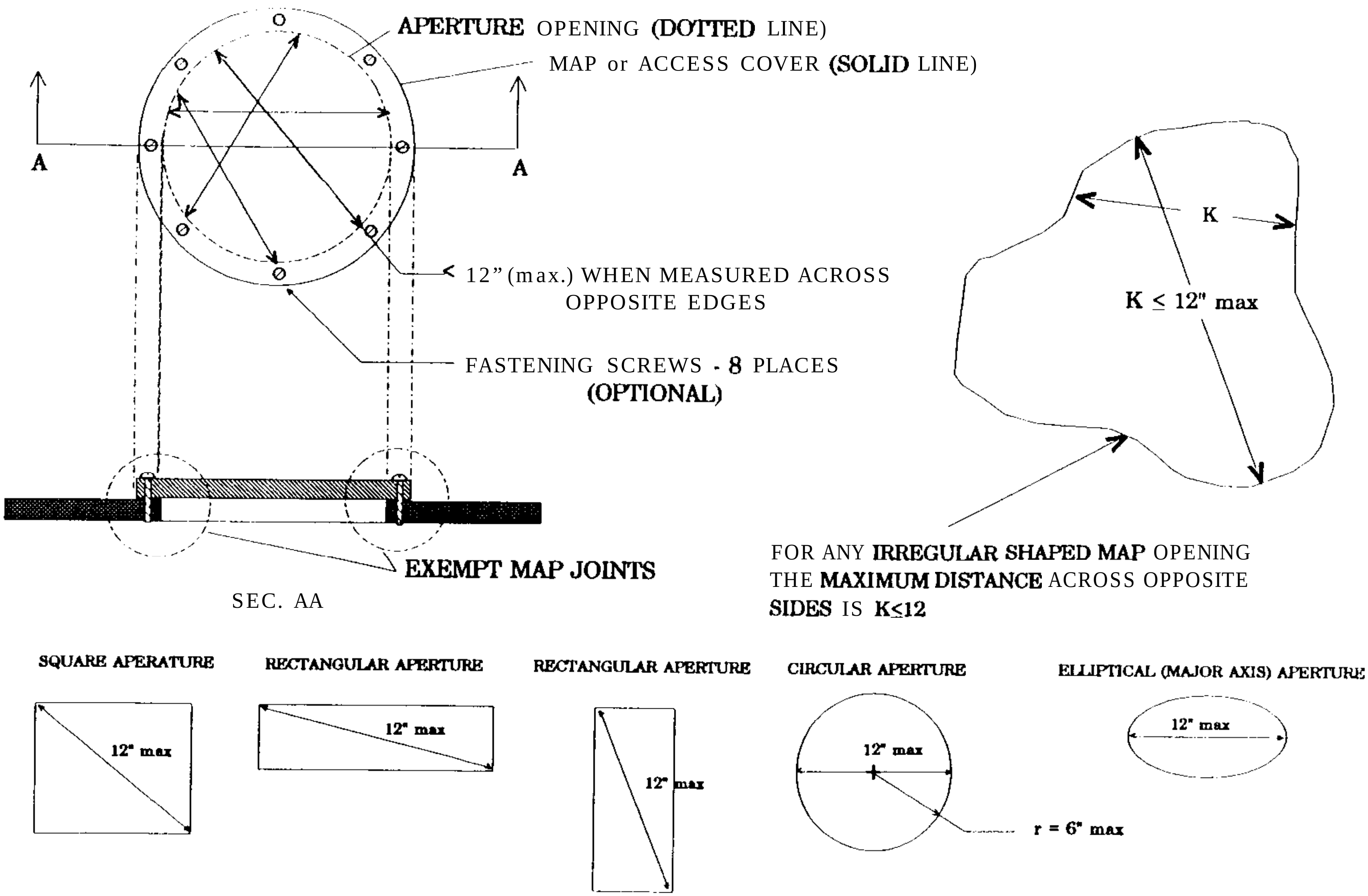
of moderate to severe school bus crashes, the agency believes this data demonstrates a frequency of MAP separation of 8.75 percent (7/80). The agency notes that there were 7 MAP separations (6 large + 1 small bus) in 80 cases and that these were described by NTSB as moderate-to-severe types of crashes.

In addition, NTSB and TRB have both recommended that the agency remove the MAP exemption from FMVSS No. 221, but neither organization estimated the potential safety benefits. Furthermore, NHTSA is not aware of any changes in school bus MAP design practices/ procedures and has observed that the 1995 National Standards for School Transportation do not contain any MAP design recommendations.

NHTSA representatives visited a large school bus maintenance depot in Montgomery County, MD to study MAP designs, the types of serviceable components needing access, and access frequency. One Blue Bird, one Thomas Built and one Carpenter school bus were inspected. No serviceable components within the passenger compartment, and needing access annually, were observed. Lamps/reflectors for exterior signals are replaced from outside the bus. MAPs probably covering wire harnesses were observed above the left side windows and in the rear of each bus. These wiring harnesses carry power to overhead dome lights and speakers as well as to the rear lights and signals. However, MAPs above the driver's head and the front service door would be exempt as they would be outside the "passenger compartment," per the subject rule. No MAPs were observed in the firewall area. Transit style school buses with rear engines may need repairs periodically requiring access from inside the bus. One MAP was noted on the floor, within the passenger compartment, allowing access to the fuel sending unit. However, access frequency was greater than one year intervals. (See Trip Report, Docket No. 73-34-N10-022)

The agency experimented with several full size mock-ups using the proposed 2-inch (5 cm) perimeter around the periphery of "hypothetical" serviceable components and agrees with the commenters that 2-inches (5 cm) might be too restrictive. After considering the school bus field observations, the agency has decided to increase the maximum exempted aperture openings, for the final rule, to 12 inches (30 cm) when measured across opposite aperture edges. See Figure III-1 for details. The aperture opening would be independent of the serviceable component's perimeter and location. This allows asymmetric placement of serviceable components relative to the aperture. The size of this maximum allowable opening would be responsive to many of the commenters concerns and would be somewhat consistent with the 144 $in.^2$ suggested by Mid Bus. The 4 inches (10 cm) average maximum distance between components, such as a cluster of components, has been deleted from the final rule as no component clusters were identified by the commenters or observed in the field.

Under the final rule, MAPs outside the passenger compartment space are excluded from the 60 percent joint strength requirement of FMVSS No. 221. MAPs inside the passenger compartment necessary to access one or more high frequency maintenance serviceable components (at intervals of at least once per year) by way of an aperture opening greater than



EXAMPLES OF EXEMPTED MAPs

Figure III-1

12 inches (30 cm) when measured across opposite edges would be required to comply with the 60 percent joint strength requirements of FMVSS No. 221.

Manufacturers have two options for complying; (a) redesigning school bus MAPs (such as by using smaller apertures at serviceable components requiring accessibility within a one year period of time), or (b) adding extra fasteners such as screws to existing MAPs.

C.1(b) Floor MAPs As discussed in C3., floor joints will be required to meet FMVSS No. 221. MAPs that expose the bus interior to areas located below the bus floor, or within the engine compartment, are treated like any other MAP and are excluded only if the MAP meets the restrictions of either MAP location or size.

C. 1(c) Passenger Compartment Definition While most commenters were satisfied with the proposed "passenger compartment" space definition proposed for FMVSS No. 22 1, Ford suggested that the agency adopt the "passenger compartment" definition from the FMVSS No. 2 17 NPRM ". .the space within the school bus interior that is between a vertical transverse plane located 30 inches (76 cm) in front of the forward most passenger seating reference point and a vertical transverse plane tangent to the rear interior wall of the bus at the vehicle centerline." NHTSA concurs with Ford and has adopted the new FMVSS No. 217 language for "passenger compartment" for the subject final rule. This language was proposed in the "Bus Window Retention and Release" NPRM, March 15, 1991 (56 FR 11153) and subsequently was adopted in the revised FMVSS 217 final rule entitled "Bus Emergency Exits and Window Retention and Release" November 2, 1992 (57 FR 49413)]. This definition applies to both large and small buses.

C. 1(d) Perforated Steel and Non-Metallic MAPs Because of the lack of static and dynamic test data concerning the performance of non-metallic MAPs (e.g., fiberglass and other plastic materials), the agency has concluded that this issue is beyond the scope of the final rule. Several commenters suggested the idea of non-metallic MAPs, but did not follow through with performance data or further develop their idea in writing. The utilization of non-metallic materials for MAPs, and school buses in general, is an issue for consideration in future rulemaking.

Several commenters were concerned whether FMVSS No. 221 applied to perforated steel panels which employ a series of closely drilled or punched holes, backed with fiberglass, to absorb sound. Because these panels are primarily used in the interior ceiling areas of the bus

between roof bows, and may be structural in nature, NHTSA has concluded that perforated steel panels must meet S5.

C. 1(e) Interior Engine Covers - In the final rule, the agency has exempted front and rear engine access covers. For small, van-based school buses, such covers would already be exempted since they are part of the cutaway chassis or are forward of a transverse vertical plane 30 in. in front of the forward most seating reference point (SRP). For rear engine, transit style buses. interior engine covers which are, by definition, within the passenger compartment would be exempted from S5.1 and S5.2. Informal communications with Blue Bird Body Co. indicated that they manufacture several buses with rear mounted engines (about 10 percent of sales) that require periodic access from the interior passenger compartment at intervals of less than one year.

C.1(f) Impact of MAP Definitions on Maintainability/Repairability/Safety - Many of the commenters were concerned about a potential for: (1) a decrease in the quality/frequency of maintenance/repair, and increased cost, because too many fasteners will be needed for MAPs certified to S5, (2) mechanics to experience more cuts and abrasions because of tighter working areas, (3) student injuries to increase because of smaller MAPs, (4) the new requirements to make retrofitting buses with new safety devices more expensive, and (5) a degradation in safety because mechanics will not take the time to replace all the fasteners in a 60 percent MAP panel.

NHTSA can do little, if anything, to directly regulate solutions to the above potential problems. However, NHTSA believes its decision to increase the maximum exempted MAP opening (compared to the NPRM) will alleviate many of these problems. The school bus manufacturers have control of the entire design process, not NHTSA. The agency believes that the school bus manufacturers possess the ingenuity and creativity to solve these potential problems and that sufficient flexibility has been built into the final rule to ensure that school bus designers and product design engineers can accommodate these concerns. The bus manufacturers, ultimately, define which components are "serviceable components" and require periodic maintenance and whether the maintenance interval is one year or less. If exempted MAPs are desired, NHTSA is confident that they will prudently execute designs which will ensure ease of accessibility of mechanics' hands and tools, minimize the number of fasteners needed to remove or replace the MAP aperture cover, facilitate future retrofitting and eliminate sharp edges in the MAP opening or cover which might produce hand injuries. If exempted MAPs are not selected as a design solution, and 60 percent joint strength MAPs are utilized, NHTSA is confident that means such as electrical conduits or channels connecting exempted MAPs can be used to facilitate retrofitting of wires without removing/replacing certified MAPs.

C.2 Extend the Standard to Small, Type-A School Bus MAPs and Body Joints A number (6/20 =0.30) of small school bus crashes have been documented by NTSB in which interior/exterior body joint separations occurred (Small School Bus Study, Cases Nos. 10, 11, 13, 14, 16 and 17). In one of the cases (No. 13, Houston, TX) MAP failure occurred without injury and in another case (No. 16 Elmhurst, IL), AIS 3 leg injuries are believed to have been related to sheet metal being peeled back along the side of the bus from the B-pillar to the rear axle. In Case No. 17 (Chester County, PA), after a head-on collision with a truck, the occupant compartment integrity was violated due to structural collapse and floor buckling. Although available from the manufacturers as optional safety equipment, none of the small, Type-A school bus crash cases reported by NTSB, except Snyder, Oklahoma are believed to have been built with joints certified to FMVSS No. 221. Although Texas is one of the states subject rule, and the FMVSS 221 body joint requirements should apply to small, Type A school buses.

In addition, NTSB discovered that small, Type A school bus MAP and interior/exterior body joints have been failing in crashes and recommended that NHTSA study the issue of extending the standard to this size school bus. The agency notes that all of the major small school bus manufacturers already offer small, Type A school buses with a FMVSS No. 221 joint strength option and that 43 percent (22/51) of the states (including DC) require their small school buses to be purchased with FMVSS No. 221 certified joints. This implies that 35 percent (sales weighted estimate) of new small, Type A school buses are already in compliance with FMVSS No. 221. Historically, small, Type A school buses have been required to meet all the large school bus standards, except FMVSS No. 221.

In their small school bus crashworthiness study, NTSB recommended that NHTSA collect and evaluate crash data involving small school buses to ascertain whether school buses with a gross vehicle weight rating of 10,000 lbs. (4,536 Kg.) or less should be required to meet the joint strength requirements of 221. No small school bus injury data (anecdotal or otherwise) were provided by the commenters to the NPRM. No new small school bus injury data related to MAPs or joints has been reported since the NPRM was issued. Using the Snyder, Oklahoma crash to support its position, and recognizing that small, Type-A school buses are under represented in crashes as a whole, NHTSA has decided to mandate the extension of FMVSS No. 221 to small school buses. The rationale is as follows:

1 Equivalent Structural Integrity Over the last 13-14 years there have been a number of severe, large school bus crashes in which the bus body was separated from the chassis (e.g., Snow Hill, NC; Bronson, FL; Tuba City, AZ; St. Louis, MO;. and Palm Springs, CA) with the result that, although there were local impact deformations, overall the bus body integrity remained intact.[4,5] The agency feels strongly that the same, equivalent level of structural integrity afforded large buses should be required for small school buses through the extension of FMVSS No. 221.

2. Higher Crash Forces In a multi-vehicle collision involving a school bus, the agency believes that the structure of the small school bus will be subjected to higher g levels (higher acceleration levels) compared to the large school bus, all things being equal (e.g. speed and weight of the striking vehicle, road conditions, etc.). Thomas Built and Blue Bird noted this point in their comments. In their small school bus report, NTSB made a similar comment: "First, in most crash scenarios, the body joints of a small school bus will be tested far more than those of a large school bus. Size and mass of a motor vehicle are extremely important considerations in crash severity. For example, in a collision between

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[4] Collision of Tuba City School District School Bus and Bell Creek, Inc., Tractor--Semitrailer, U.S. 160 near Tuba City, Arizona, April 29, 1985, Highway Accident Report, National Transportation Safety Board, NTSB/HAR-85/06, PB85-916207.

[5] School Bus Loss of Control and Collision with Guard Rail and Sign Pillar, U.S. Highway 70 near Lucus and Hunt Road St. Louis, Missouri, November 11, 1985, Highway Accident Report, National Transportation Safety Board, NTSB/HAR-87/02, PB87-916203.

a school bus weighing 20,000 lbs. and passenger car weighing 4,000 lbs., the crash forces acting on the school bus and its occupants will be far less than if the school bus weighs 6,000 lbs. Similarly, if a small school bus collides with a heavy truck, the crash will stress the small school bus far more than the large school bus." Adequate and uniform levels of safety are needed.

3. It is desirable to have "equivalent" body joint strength requirements, regardless of bus size. Many of the agency's standards which are applicable to large school buses are also applicable to small school buses (e.g., FMVSS Nos. 111, 131, 217, 220, 222).

4. The agency believes that small, Type-A school buses are more often used in the transportation of disabled/special education students in this country than larger school buses. A recent survey conducted by School Bus Fleet magazine, December/January 1993, indicates that 18 to 20 percent of public/contractor small school buses are lift-equipped, whereas only 5 to 7.8 percent of public/contractor large school buses are lift-equipped.

5. It is believed the small school bus crash near Snyder, Oklahoma in 1993 was equipped with 221 compliant joints. Despite being impacted on the right-side by a tractor-trailer truck at 48-52 mph, the small school bus body was still intact without apparent body joint separations. There were no MAP or body joint separation problems noted by NTSB in their investigation report.

6. 12th National Conference on School Transportation (See 1995 National Standards, page 27) held in Warrensburg, MO in May 1995, supported extension of FMVSS No. 221 joints to small school buses.

C.3 FMVSS No. 221 Applies to Floor Joints Based on the Bronson, FL school bus crash (August 28, 1987) in which floor joint separation contributed to the death of an 11 year old boy, and the Snow Hill, NC (May 31, 1985) school bus crash with floor joint failure and 2 possible fatal ejections, NHTSA re-confirms by way of this rulemaking that FMVSS No. 221 applies to floor joints as well as body joints. In their NPRM comments (Docket No. 73-34-N08-040), the Center for Auto Safety (CAS) stated that ".. with the exception of one manufacturer (Thomas Built Buses), FMVSS No. 221 has been very effective in preventing floor joint separations. [CAS was referring to the August 28, 1987, school bus crash near Bronson, FL in which the collapse of the floor of a 1982 Thomas Built Bus contributed to the death of an 11-year-old boy. The boy, who was pinned between collapsed floor panels, died before he could be extricated. The agency notes an earlier 1982 Thomas Built Bus floor separation in NTSB's large school bus Case No. 14, Snow Hill, NC, 5/31/85.] It should be noted that in May, 1989 Thomas Built notified NTSB that they had upgraded the number of spot welds across the entire width of the floor from 12 to 48 on each floor joint. References 12 and 13 contain crash tests of the new floor joint system designed by Thomas Built Buses in response to NTSB's August 15, 1989: Recommendation H-86-57 - ". .strengthen the floor joint panels of all newly-manufactured school buses to ensure they comply with the requirements of FMVSS No. 221."]

C.4 Improve "Objectivity" of the Standard Although considered, no changes will be made to the relative strength requirements of FMVSS No. 221. It is known that the school bus manufacturers utilize many different thicknesses (gauges) of steel in constructing their bus bodies depending on the type and location of the joint. The agency believes this approach is typical of the industry as a whole. The thickness of the panels and structural members typically range from 0.034 to .625 inches, a range of 20 to 1. Therefore, regulating minimum absolute strength (via specifying gauge or steel thickness) is extremely design restrictive and incompatible with current design practices and procedures. It would force manufacturers to overdesign their lightly loaded joints and build costly new tooling.

Therefore, building to the heaviest loaded joint (or thickest gauge and "least common denominator," somewhere between 18 and 22 gauge steel as suggested by the commenters) would result in needless increases in the vehicle weight, manufacturing costs, and operating costs for school buses without corresponding safety benefits.

The agency is satisfied that the current requirement of 60 percent joint strength of the weakest joint member has not resulted in a degradation of safety. According to the standard, a manufacturer could legally select a weak material, thus lowering overall joint strength and reduce the number of fasteners (e.g., thus reduced labor costs) needed for assembly. Standard industry practice and procedures have not allowed this to occur. Investigations of school bus crashes by NTSB show "high" structural integrity of school bus bodies using the current FMVSS No. 221 requirements. Although an absolute joint strength requirement was proposed in the NPRM, NHTSA has decided to maintain the existing successful relative strength approach for the final rule.

In their large school bus study, NTSB indicated that the current provisions of FMVSS Nos. 220, 221, and 222 are adequate. In their report, NTSB stated ". .the bodies of post-standard school buses maintained their integrity very well during quite severe crashes; this was not the case in many pre-standard school bus crashes investigated by the Board." Further, NTSB's Conclusion 8 stated ". .the post-1977 federal school bus standards requiring increased side panel and roof strength appear to have been successful in eliminating the structural failures responsible for many of the ejections which occurred in pre-standard school buses." In their report entitled "Improving School Bus Safety", TRB stated "...the Committee believes that the federal school bus safety standards that went into effect in 1977 (e.g., FMVSS No. 217, 220, 221, 222, and 301) have been effective in reducing the number of fatalities and injuries to school bus passengers."

The final rule excludes trim, decorative parts, floor coverings, molding strips, and ventilation panels from the requirements of FMVSS No. 221 as these are, generally, non-structural components or non-metallic components to which FMVSS No. 221 does not apply. The proposed smaller, rectangular specimen, designed to improve the number of joints tested, has not been adopted in the final rule as the commenters believed it was impractical. Similarly, the testing of curved, complex joints has not been adopted in the subject final rule, as considerable costs would be incurred for what are believed to be marginal benefits. In addition, body frames to which doors and windows are mounted are excluded from FMVSS No. 221. NHTSA uses only body joints from actual vehicles in compliance testing. Thomas Built and Blue Bird both mentioned that they must use surrogate joint test procedures in order to develop and certify complex joint designs (e.g., body/window and body/door frame intersections or body corner frames). NHTSA recognizes, from a practical point of view, that manufacturers need to know the strength of complex joints and, therefore, must test surrogates. However, the subject final rule does not mandate the use of surrogate joints in FMVSS No. 221 compliance tests.

The meaning of "approximately perpendicular" has been made more objective; the final rule states that the test machine grips are adjusted so that the applied tensile force will be at 90 degrees to the joint centerline within +/-3 degrees. Blue Bird commented that a +/- 1 degree tolerance was practicable.

In calculating the tensile strength of each joined component, the total area of the material removed for installation of fasteners will be counted toward the determination of the tensile strength of the weakest joined panel.

IV. BENEFITS

Studies of school bus crashes by NHTSA's Special Crash Investigation (SCI) Division and the National Transportation Safety Board (NTSB) have indicated that MAP joints on large school buses have separated during crashes, exposing or creating sharp, cutting edges, and that injuries have been produced by the failure of these panel joints. The subject final rule eliminates the exemption status previously granted to MAPs, unless certain design restrictions are met. An exempted MAP aperture opening would (1) be reduced in size so as not to exceed a 12 inches (30 cm) distance when measured across opposite edges, in any direction, and (2) would have to be used to access a serviceable component as well as require access at least once a year, as defined by the manufacturer. If the MAP size and access frequency requirement are not achieved, and the MAP is within the occupant compartment space, the MAP joint must meet the 60 percent joint strength requirement of S5 of the rule.

It is logical that if overhead MAPs are required to meet 60 percent joint strength, or an alternative design, fewer MAP separations will occur in moderate-to severe crashes and injury potential will be greatly reduced. Similarly, it is logical that if small school bus body joints are required to meet 60 percent joint strength, fewer joint separations will occur in more severe crashes and their injury potential will be greatly reduced.

In addition, NTSB discovered that small, Type-A school bus MAP and interior/exterior body joints have been failing in crashes and recommended that NHTSA study the issue of extending the standard to this size school bus. The agency notes that all of the major small school bus manufacturers already offer small, Type-A school buses with a FMVSS No. 221 joint strength option and that 43 percent (22/51) of the states (including DC) require their small school buses to be purchased with FMVSS No.221 certified joints. This implies that 35 percent (sales weighted average estimate) of new small, Type-A school buses are already in compliance with FMVSS No. 22 1. Historically, small, Type-A school buses have been required to meet all the large school bus standards, except FMVSS No. 221.

In a report prepared by Ultrasystems, Inc. entitled "An Analysis of School Bus Accidents", October, 1976, (Contract No. DOT-HS-6-01346), 3 of the 61 (5 percent) school bus crashes examined had injuries resulting from the separation of interior panels. These were pre-1977 buses and MAPs were not implicated as a cause of injury. In 1981 when NHTSA initially investigated the MAP exemption issue, MAP separations had been recorded, but no injuries resulted. At that time, the agency had tentatively concluded that many of these panels were located in areas of the school bus most likely to be struck by the heads of the passengers and that they posed a <u>safety hazard</u>. In the St. Louis, MO large school bus crash (Case No. 13) and the Tuba City, AZ large school bus crash (Case No.43), NTSB confirmed that separated MAPs caused head lacerations. There were four other cases of MAP separations (including the 1991 Palm Springs, CA case) which occurred in the large buses studied by NTSB, but no injuries occurred. One of the small, Type-A school buses (Case No. 13, a van conversion) had an MAP separation (without injury) and none of the 5 large, Type-B buses NTSB studied had any MAP separations.[4] [Cases in parentheses are contained in the NTSB large (3/18/87) or small (10/11/89) school bus studies.]

There were several catastrophic school bus crashes: Case No. 16 (small bus, Elmhurst, IL) the side-wall peeled back against a NJ median barrier and the belted occupant received multiple AIS-3 leg injuries. It is assumed that this was not a 221 compliant bus body as it was a 1982 model year bus and, further, Illinois is not one of the states that require small school buses to be purchased with 221 compliant joints. The assumption is made by NHTSA, later in the benefits section, that extending FMVSS 221 to small school buses would prevent this from happening. Case No. 14 (Snow Hill, NC) involved catastrophic collapse of the large school bus body with 4 fatal ejections from the side wall and possibly 2 fatal floor separation ejections. In Case No. 17 (small school bus, Chester County, PA) structural collapse of the bus front-end occurred and the floor buckled in what would appear to have been a severe crash in which 2 bus occupants died. No mention of MAP or body joint separations was made by NTSB in its report. NHTSA does not believe that extending 221 to small school buses would have mattered and, therefore, the latter two cases are excluded from benefits. Similarly, for Franklin, NC, the roof of the large school bus was sheared-off by a 16,000 lbs. concrete block and 2 bus occupants died. Based on preliminary information from NTSB, NHTSA believes that none of the countermeasures in the subject final rule would have changed the outcome of this crash either.

Table I-1 shows a <u>large</u> bus MAP separation frequency of 10 percent (6/60) with 2 injuries and Table I-2 shows a <u>large</u> bus body joint separation frequency of 1.60 percent (1/60). [Note: 3 NTSB large school bus cases (e.g., Bronson, FL, Snow Hill, NC, and Franklin, NC were not included in this calculation as they were considered catastrophic and irrelevant.) Similarly, There were several catastrophic school bus crashes: Case No. 16 (small bus, Elmhurst, IL) the side-wall peeled back against a NJ median barrier and the belted occupant received multiple AIS-3 leg injuries. It is assumed that this was not a 221 compliant bus body as it was a 1982 model year bus and, further, Illinois is not one of the states that require small school buses to be purchased with 221 compliant joints. The assumption is made by NHTSA, later in the benefits section, that extending FMVSS 221 to small school buses would prevent this from happening. Case No. 14 (Snow Hill, NC) involved catastrophic collapse of the large school bus body with 4 fatal ejections from the side wall and possibly 2 fatal floor separation ejections. In Case No. 17 (small school bus, Chester County, PA) structural collapse of the bus front-end occurred and the floor buckled in what would appear to have been a severe crash in which 2 bus occupants died. No mention of MAP or body joint separations was made by NTSB in its report. NHTSA does not believe that extending 221 to small school buses would have mattered and, therefore, the latter two cases are excluded from benefits. Similarly, for Franklin, NC, the roof of the large school bus was sheared-off by a 16,000 lbs. concrete block and 2 bus occupants died. Based on preliminary information from NTSB, NHTSA believes that none of the countermeasures in the subject final rule would have changed the outcome of this crash either.

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Table I-1 shows a small school bus MAP separation frequency of 5 percent (1/20) with zero injuries and Table I-2 shows a small school bus body joint separation frequency of 20 percent (4/20), one with AIS-3 multiple leg injuries. [Note: Include NTSB small bus investigation Cases #10, #11, #14 and #16. Case #17 was deleted as being too catastrophic.]

Because of the severity of several of the small, Type-A school bus crashes investigated by NTSB (No. 16 & No. 17), NHTSA is uncertain that, in these cases, 60 percent joints as prescribed by FMVSS No. 221 would have made a difference. NHTSA eliminated some school bus crashes from further consideration as they were catastrophic in nature and probably not amenable to the countermeasures of the subject final rule. NHTSA determined that 6 large school bus cases (2 involving injuries) and 1 small school bus MAP separation case (involving no injury) could be improved by the subject rule. Relative to body joint separations, the two large school bus cases (Snow Hill, NC and Bronson, FL) with floor separations would not be amenable to the final rule as the Thomas Built Bus floor joint welding problem was corrected many years ago in 1989. The agency assumes the one small school bus (Case No. 16) with side wall separation and AIS-3 leg injuries would be amenable to improvement based on the subject rule. The agency assumes that for a severe small school bus crash like the one in Chester County, PA (Case #17), FMVSS No. 221 compliant joints probably would have been irrelevant.

As discussed earlier, NHTSA estimates that the type of crash NTSB investigates, where MAPs and body joints separate, occur in only 1.0 to 6.4 percent (2,216/221,009 to 14,147/221,009 over 9 years) of all school bus crashes which occur annually. (See Appendix for unweighted/weighted crash counts.)

Quantification of Benefits

Large Bus MAPs Approximately 6 of 60 large buses had relevant MAP separations and 2 out of 6 had head laceration injuries. Based on 1988-96 GES files, there are 2,216 to 14,147 crashes out of 221,009 total crashes (9 years of data) which would meet the NTSB selection criteria or 1.0 to 6.4 percent of all school bus crashes annually. Therefore, there are about 246 (.010 X 24,557) to 1,572 (.064 X 24,557) NTSB-type school bus crashes annually in the U.S. of which 84 percent or 207 to 1,320 are large school buses.[1] Only 10 percent (6/60) are estimated to have MAP separations or 21 to 132 large school bus crashes annually. The agency assumes that if the bus crash is of lower severity than the NTSB selection criteria, MAP separations do not occur. There were 2 head injuries in 6 NTSB large school bus crash cases or a 33 percent injury rate given an MAP separation occurred. The target injury population is 7 to 44 injuries [(21 X .33) to (132 X .33)] per year. Assuming 75 percent effectiveness, the agency's MAP requirement may forestall 5 to 33 AIS 1-3 injuries per year.

In order to calculate the injury reduction benefits, the effectiveness of the MAP/joint strength requirements had to be estimated. The effectiveness of these requirements is unknown, but it is believed to be fairly high, since NTSB found no joint separations in those areas covered by

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It is estimated that approximately 84 percent of annual sales are large school buses and 16 percent are small school buses.

the current standard except large bus Case #24 (see NTSB small school bus report). The agency was not able to use the estimate of 100 percent effectiveness, since occupants can be injured by striking the panels themselves. Occupants may receive a more severe injury if the panel comes loose, exposing a sharp edge.

For purposes of Table IV-1, Summary of Benefits, the calculation method in which the injury rate of large buses, which had the most data, is applied to both large and small buses is called Method 1. Under Method 2, the large and small bus injury rates are combined or averaged together. Therefore, combining large and small bus MAP injury rates yields 0.2857 (2/7) as 2 injuries occurring in 7 buses with MAP separations. Under Method 2, the target injury population becomes 6 to 38 injuries [(21 X .2857) to (132 X .2857)] per year. Assuming 75 percent effectiveness, the agency's MAP requirement may forestall 5 to 29 AIS 1-3 injuries per year.

Large Bus Floor Joint Separations - The floor joint separation problem exhibited by 1982 Thomas Built Buses was corrected in 1989 and brought up to the strength level of other buses. Re-confirming the applicability of 221 to floor joints is not expected to produce any benefits. Although not explicitly stated in the FMVSS No. 221 regulation, various interps by the agency have clarified the applicability of 221 to floor joints which are the same as bus body joints. One Type-B (Case #24) a large bus investigated by NTSB, but included in the small school bus report, had an interior body joint separation, but 221 joint strength already applies. Therefore, under Method 1 and 2, the benefits are zero because FMVSS already applies to large buses.

Small Bus MAPs One out of 20 small school buses had MAP separations which resulted in zero injuries. There are 246 to 1,572 NTSB type school bus crashes annually in the U.S. of which 16 percent are small school buses or 39 to 251. Approximately 5 percent (1/20) of small school buses in moderate-to-severe crashes have MAP separations or 2-13 [(.05 X 39) to (.05 X 251)] bus crashes per year. NHTSA assumes that in a small bus crash of lower severity than the NTSB selection criteria, MAP separations do not occur. Since there was only one small school MAP separation without an injury, Method 1 uses the MAP injury rate for the large school buses or 0.3333. Therefore, the target population is 1-4 AIS 1-3 injuries [(2 X .3333) to (13 X .3333)] per year. Assuming 75 percent effectiveness yields 0-3 AIS 1-3 laceration-type injuries forestalled annually due to the subject final rule for small school buses.

However, under calculation Method 2, the small school bus and large school bus injury rates averaged together yields 0.2857 (2/6 + 0/1). This results in a target population of 1 to 4 injuries [(2 X .2857) to (13 X .2857)] per year for small school buses due to MAP separations. Assuming 75 percent effectiveness yields 0-3 AIS 1-3 laceration-type injuries forestalled annually due to the subject final rule for small school buses.

Small Bus Body Joints - There were 4 small school bus body joint separations (excluding the MAP case), 1 of which resulted in multiple AIS-3 leg fractures to one occupant. There are 246 to 1,572 NTSB type school bus crashes annually in the U.S. of which 16 percent are small school buses or 39 to 251. Approximately 20 percent (4/20) of the small school buses investigated by NTSB in moderate-to-severe crashes had body joint separations or 8-50 [(.20 X

39) to (.20 X 251)] bus crashes per year. The bus body joint injury rate for small school buses was one AIS-3 injury out of 4 relevant buses with body joint separation or .25 (1/4) injuries per bus crash with body joint separation (e.g., Case #16 divided by #10, #11, #14, #16). For small school buses it is estimated there would be 2 to 13 [(8 X .25) to (50 X .25)] AIS-3 injuries per small, Type-A bus from body joint separations per year. Applying a countermeasure effectiveness rate of 75 percent, yields 2 to 10 AIS-3 injuries forestalled per year from extending FMVSS No. 221 body joint requirements to small school buses. This is Method 1 calculation methodology.

Despite large school bus have a zero body joint injury rate, the results under calculation Method 2 would be modified because the combined body joint injury rate denominator will changed. Referring to Table I-2, 5 small bus body joint separations will be combined with 1 relevant large bus body separation (NTSB Case #24). For this calculation, the analysis excluded 3 large school buses: the 2 floor joint cases in Bronson, FL and Snow Hill, NC as well as the Franklin, NC case. This yields a total of 6 in the denominator and 1 small bus body joint injury (AIS-3) in the numerator or a 0.1667 (1/6) combined injury rate. Using a combined injury rate, it is estimated there would be 1 to 1 1[(10 X 1667) to (63 X .1667)] AIS-3 injuries per small, Type-A bus from body joint separations. Applying a countermeasure effectiveness rate of 75 percent, yields 1 to 8 AIS-3 injuries forestalled per year from extending FMVSS No. 221 body joint requirements to small school buses.

Table IV-1
Summary of Estimated Annual Benefits

Countermeasure Type	Method 1	Method 2	
Improve Large School Bus MAPs	5 - 33	5-29	AIS 1-3 injuries.
Improve Large School Bus Body Floor Joints (221 already applies)	0	0	
Improve Small School Bus MAPs	0-3	0-3	AIS 1-3 injuries
Improve Small School Bus Body Joints	2-10	1-8	AIS-3 injuries.
Total	5-36	5-32	AIS 1-3 laceration injuries
	2-10	1-8	AIS 3 fracture injuries.

NHTSA estimates that about 5-36 (Method 1) or 5-32 (Method 2) AIS 1-3 laceration-type injuries per year could be forestalled by improving MAP design and 2-10 (Method 1) and 1-8 (Method 2) AIS-3 fracture-type injuries per year could be forestalled by improved body joint strength for both large and small buses.

The body joint injury severity levels reduced or eliminated are estimated to be AIS-3. In the Bronson, FL large school bus crash, an 11 year old boy's death was contributed to by floor joint separation, and in the Elmhurst, IL (Case #16) small school bus crash the side wall of the body opened-up and a belted occupant sustained multiple leg injuries of AIS-3 (e.g., open fractures of the left and right tibia and closed fracture of the femur). For the MAP separations, the Tuba City, AZ (Case #43) and St. Louis, MO (Case #13) the scalp laceration was in the AIS 1 to AIS-3 range. NTSB investigators did not specify.

The legislative history for the 1974 Bus Safety Amendments indicated that the impetus for legislation was not the desire for cost-effective requirements, but rather that maximum safety should be provided for school age children.

V. COST

The agency's final rule specifies that MAPs exempted from FMVSS No. 221 cannot exceed specified dimensions, and can be located only at serviceable components which must be accessed at intervals of one year or less. Costs will be associated with new tooling for the access panel opening, access panel cover, and screws/fasteners. Dedicated channels between exempted MAPs, running on one side of the bus from the front to the rear, could be used to carry overhead lighting, rear signaling, and emergency exit warning device wires. A conduit or duct system, for example, would allow for the wires to be retrofitted according to customer safety equipment specifications. Wires could be removed or replaced using this technique, if necessary.

No new comments (NPRM compared to ANPRM) were received from school bus manufacturers as to the incremental costs associated with the product design and engineering, as well as tooling costs associated with the new MAP proposal.

A. Large Bus Incremental Consumer Cost (1996$)

One major school bus manufacturer (Blue Bird) contacted by NHTSA in June, 1990, indicated that redesigning exempted MAPs or building in 60 percent joint strength to unexempted MAPs, would result in incremental consumer costs of $147 (35 pass. bus), $209 (66 pass. bus) and $270 (84 pass. bus) per large bus.[1] These retail prices include variable costs, fixed

[1] Letter from Blue Bird dated August 31, 1989 containing school bus optional equipment cost data (Docket no. 73-34-N01-052) and Cost and Installation Data required for School

factory overhead, tooling, manufacturer's profit and dealer's profit margin and have been updated from 1989 to 1996 economics. Assuming that MAP compliance costs are proportional to bus capacity, the agency estimates that the cost for a small, Type-A (or large, Type-B school bus) with 10-20 passenger capacity, MAP compliance would be about one-half that of a 35 passenger bus or $74 ($147/2). Table V-1, School Bus Sales by Body Type and Model Year (1990-97), indicates that combined small and large school bus sales average about 35,000 units per year.[2] As Table V-1 also shows that about 84 percent of the annual school bus production is large buses and 16 percent is small, Type A buses. Assuming that the Blue Bird estimates are representative of the industry, the sales weighted average consumer cost of eliminating the MAP exemption can be calculated. [Note: MAP cost data from 1989 was updated to 1996 economics using an inflation factor of 1.228 (110.21/89.72). The 1996 GDP deflator of 110.21 was divided by the 1989 GDP deflator of 89.72 obtained from the Bureau of Economic Analysis, Department of Commerce.]

Buses, December 14, 1990 (Docket No. 88-21-N01-056).

School Bus Fleet, 1996 Fact Book Issue, January, 1996, Statistics: School Transportation 1993-94 School Year, Bobit Publishing Company, 2512 Artesia Blvd., Redondo Beach, CA, 90278-3296, [(310) 376-8788]

Table V-1
School Bus Sales by Body Type and Model Year (1990-97)

Year	A	B	C	D	Total
1990	5,085	715	23,670	6,286	35,756
1991	5,601	709	21,370	6,864	34,544
1992	6,105	571	16,444	5,444	28,564
1993	6,130	649	18,928	6,734	32,441
1994	6,018	701	21,005	7,321	35,045
1995	5,126	728	20,861	9,671	36,386
1996	5,581	367	22,016	9,270	37,234
1997	4,480	380	22,885	9,323	37,068
avg.	5,516	603	20,897	7,614	34,630
Percent	15.93	1.74	60.34	21.99	100

Source: School Bus Fleet, 1996 Fact Book Issue, January, 1996, Bobit Publishing Company, 2512 Artesia Blvd., Redondo Beach, CA 90278-3296. The Type A to Type B ratio was obtained from School Transport News, January 1995 issue, 700 Torrance Blvd., Suite C, Redondo Beach, CA 90277. Phone call 11/26/97 to School Bus Fleet magazine (310) 376-9043 to Steve Harano for 1996 and 1997 data. Type A small school buses < = 10,000 lbs. GVWR. Type B, C and B large school buses > 10,000 lbs. GVWR.

As shown in Table V-1, Type B (10-20 capacity), Type C (24-77 capacity), and Type D (78 + capacity) average percent of sales are estimated to be 1.74 %, 60.34%, and 21.99 %, respectively. (Note: A rounded annual sales of 35,000 units was used in total cost estimates.) Employing the above cost data provided by Blue Bird, the large school bus sales weighted average consumer cost (SWACC) would be $222.16 per unit [(.0174 X $74) + (.6034 X $209) + (.2199 X $270)/.8407]. The total consumer cost of eliminating MAPs for large school buses is estimated to be $6,526,800 (.84 X $222 X 35,000). Although Type-C school buses can range from 24 to 77 passengers, the agency has assumed that the 66 passenger bus (hence $209 cost) is the dominant representative type. (See the Appendix for further details.)

B. Small Bus Incremental Consumer Cost (1996$)

The agency requested incremental cost data for small, Type A bus compliance with the proposed body joint and MAP requirements. Mid Bus estimated consumer costs of $1,132 per bus body, and $849 more to include chassis modifications, in order to apply the revised FMVSS No. 22 1 standard to small school buses. NTEA/MCSSB estimated $849-$1,132 per vehicle for small school bus joint testing and certification assuming NHTSA has excluded from the final rule joints produced by the chassis manufacturer or joints where the body and chassis join. Blue Bird estimated $566 per vehicle for small, Type A buses to comply. Other than these estimates, no new cost data pertinent to NHTSA's proposal was submitted by the commenters. [Note: FMVSS No. 221 compliant joint strength cost data from 1991 was updated to 1996 economics using an inflation factor of 1.132 (110.21/97.32). The 1996 GDP deflator of 110.21 was divided by the 1991 GDP deflator of 97.32 obtained from the Bureau of Economic Analysis, Department of Commerce.]

NHTSA supplemented this data by contacting each of the small school bus manufacturers, who provided the optional consumer cost information in Table V-2. Excluding some small independent conversion companies, all of the leading school bus manufacturers offer this option at an incremental consumer cost of $91-$1,087. (See Appendix for list of small school bus manufacturers.) Manufacturing costs include variable costs which will increase, however, there will be little engineering, tooling, production start-up or compliance/certification costs associated with extending the rule. The costs of extending the rule will be mostly variable costs. For 8 of the companies responding with cost information, their products ranged from $91-$1,087 per bus or an average of about $414 per bus [$192 + $566 + $91 + $530 + $434 + $850 + $447 + $198 divided by 8].

Table V-2

Small Bus Manufacturers* Contacted by NHTSA	Consumer Cost per Bus (1996$) for FMVSS 221 Joint Strength
AmTran	$192
Blue Bird Body Company	$566
Carpenter Bus Company	$ 91
Collins Bus Company	$530
Girardin	$434
Mid Bus	$614-$1,087
Superior Coach International	-**-
Thomas Built Buses	$447
Sturicorp	-**-
Van-Con	$198
Wayne Corporation	N/A (Out-of-Business)
Average Cost	$414

* Manufacturers of small buses which offer optional FMVSS No. 221 bus body joint strength, except for joints in the chassis and/or interface joints.

** Did not provide cost information, but confirmed that they offered the FMVSS No. 221 option for small school buses.

The above prices are optional equipment costs. They may be less if small bus compliance with FMVSS No. 221 is required. States that currently purchase buses meeting FMVSS No. 221 could get a cost reduction, while the other states would get a cost increase.

The agency believes that a large population of states (22), including the District of Columbia, are already purchasing small school buses with the FMVSS No. 221 option. There is one group of 11 (eleven) States that are required by their respective state laws to accept the body/chassis specifications of the Eleventh National Standards Conference on School Transportation [". .Body joints present in that portion of the Type A school bus body furnished exclusively by the body manufacturer shall conform to the performance requirements of FMVSS No. 221, School Bus Body Joint Strength." This does not include the body joints created when body components are attached to components furnished by the chassis manufacturer.] These states include IN, LA, ME, MD, MS, NV, NH, ND, OR, WV, and DC). In addition, based on information from a major bus manufacturer, there is another group of 11 (eleven) states who have independently adopted the FMVSS No. 221 standard for their small school buses (e.g., AR, FL, ID, OK, SD, KS, HI, WA, VA, TX, and KY .)

Although the degree of adoption within the latter states is unknown, and given that the agency does not have a count of each state's small school bus populations, the agency estimates that about 35 percent of the small school buses already comply with this aspect of the final rule. (See Table V-3 for this calculation.)

Table V-3
School Bus Registrations by State

Column A	Total	Column B	Total
Indiana	11,496	Arkansas	5,771
Louisiana	7,801	Florida	15,394
Maine	2,583	Idaho	2,374
Maryland	5,725	Oklahoma	6,921
Mississippi	5,314	South Dakota	1,707
Nevada	1,379	Kansas	5,816
New Hampshire	2,016	Hawaii	873
North Dakota	2,250	Washington	7,789
Oregon	4,215	Virginia	12,648
West Virginia	3,400	Texas	28,901
District of Columbia	209	Kentucky	8,634
Sub-total	46,388	Sub-total	96,828
		Column A+B	143,216

* "School Bus Fleet, 1996 Fact Book Issue, January 1996," Statistics: School Transportation 1993-94 School Year, Total School Buses = 410,673. Therefore, 143,216/410,673 = 35 percent. Column A - States that are required by their respective state laws to accept the body and chassis specifications from the 11th National Conference on School Transportation, May, 1995 and Column B - States that have adopted standard 221 for Type A school buses of their own volition.

Table V-3 shows the computation of the proportion of small buses already being purchased which comply with FMVSS No. 221 (assuming the percentage of small school buses is proportional to all the school buses registered in these 22 states) and indicates that these 22 states represent 35 percent of the bus population. The agency translates this to mean that 35 percent of annual new bus sales are equipped with the FMVSS No. 221 option. Therefore, 65 percent (100%-35%) or 3,624 (.1593 X .65 X 35,000) small bus units per year will require upgraded joint strength at $414 per unit and 100 percent or 5,576 (.1593 X 1.00 X 35,000) small bus units per year will require redesigned MAPs at $74 per unit. This represents a total incremental consumer cost of $1,500,336 [(3,624 X $414) for FMVSS No. 221 body joint strength and $412,624 (5,576 X $74)] for redesigned MAPs. The total small school bus consumer cost would be $1,912,960 ($1,500,336 + $412,624). The agency assumes that this cost will be reduced further with full production implementation.

The cost per affected vehicle for a small, Type-A school bus to conform to the subject final rule is estimated to be $343 and the average cost for a large school bus to conform to the new requirements is $222. (See Appendix for detail calculations.) At an average cost of $28,300 for a new, small Type-A school bus, the FMVSS No. 221 joint strength option would increase consumer cost approximately 1.21 percent ($343/$28,300). At an average cost of $45,280 for a large school bus, the new MAP requirements would increase consumer cost by 0.49 percent ($222/$45,280). Table V-4 shows a summary of the small and large bus consumer costs as well as the aggregate consumer costs estimated for the final rule. The total consumer cost per year for the subject FMVSS No. 221 amendment is estimated to be $8,439,760 [$6,526,800 + $412,624 + $1,500,336)].

Table V-4
Summary of Consumer Costs (1996$)

	Total Annual Consumer Cost	Consumer Cost per School Bus	$ Sales Weighted Average
1. Eliminate/redesign MAPs for Large Buses (29,425 units)	$6.527M	$147-$270	$ 222*
2. Eliminate/redesign MAPs for Small School Buses (5,576 units)	$0.413M	$74	$ 343**
3. Improve Small Bus Body Joint Strength (3,624 units)	$1.500M	$414	
Est. Total Consumer Cost	$8.440M /yr		$ 241***

* Large School Bus sales weighted average incremental consumer cost = $222/unit
** Small School Bus sales weighted consumer incremental cost (including $74 and $414 cost figures) = $343/unit.
*** Combined Large/Small Bus sales weighted average incremental consumer cost = $241/unit.
(See Appendix for details.)

The incremental cost to the consumer to eliminate/redesign large bus MAPs would be in the range of $147-$270 per bus or a sales weighted average consumer cost of $222 per unit. The sales weighted consumer cost per affected vehicle to eliminate/redesign small school bus MAPs and to improve joint strength would be $343 per unit. The overall sales weighted average consumer cost for both large and small buses combined would be $241 per unit. (See Appendix for details.)

<u>Other Cost Issues</u> One commenter (NSTA) stated that a number of potential costs for the MAPs were not discussed in the NPRM: (1) extra time for maintenance/repair due to extra fasteners, (2) increased failure of components with delayed maintenance, (3) crashes caused by

delayed maintenance, (4) cuts and abrasions to mechanics due to tight working areas, and (5) increased student injuries due to smaller panels.

NHTSA believes that sufficient flexibility has been built into the final rule to ensure that school bus designers and product design engineers can accommodate these concerns. The bus manufacturers, ultimately, define which components are "serviceable components" and require periodic maintenance and whether the maintenance interval is one year or less. If exempted MAPs are desired, NHTSA believes that manufacturers will prudently execute designs which will ensure ease of accessibility of mechanic's hands and tools, minimize the number of fasteners needed to remove or replace the MAP aperture cover, and eliminate sharp edges in the MAP opening or cover. If exempted MAPs are not selected as a design solution, and 60 percent joint strength MAPs are utilized, NHTSA is confident that means such as electrical conduits or channels connecting exempted MAPs will be considered to facilitate retrofitting of wires without removing/ replacing certified MAPs. The agency believes that maintenance costs need not increase as a result of this final rule. Better planning of maintenance areas and access to maintenance areas by the school bus manufacturers should allow small panels to be removed to accomplish maintenance tasks.

The agency's final rule requires that body joint fasteners cannot be spaced more than 8 inches apart. Based on NHTSA observations of current-practice exterior school bus body joints, it is difficult to find rivet heads on existing buses spaced more than 8 inches across. The agency sought information on the incremental costs (if any) associated with bringing interior and exterior joints into compliance with the 8 inch maximum distance requirement. No comments were received. NHTSA continues to believe this is a negligible cost.

Comments were solicited on the incremental costs associated with the revised sections of the standard in S6. Curved and complex joints were eliminated from further consideration as being too expensive.

VI. LEAD TIME

NHTSA proposed a 18 month lead time in the NPRM. No comments were received relative to this issue. In their docket comments to the 1981 NPRM removing the MAP exemption (Docket No. 73-34, Notice 05), the manufacturers argued for 18 to 24 months lead time. Wayne Corporation (now out-of-business) indicated that the machines for manufacturing and fastening each bus part are designed, built, and tooled separately. Also, the parts of the bus structure and panels are manufactured with the holes for the screws and rivets that are used to attach them. Blue Bird Body Company indicated that redesign and re-tooling would be necessary. In view of the 1981 comments, and in the absence of any new comments in 1991, NHTSA has adopted the 18 month lead time for the subject final rule.

VII. EFFECTS ON SMALL BUSINESS ENTITIES

The Regulatory Flexibility Act of 1980 (Public Law 96-354) requires each agency to evaluate the potential effects of its rules on small businesses, small organizations and small governmental jurisdictions. The small businesses and organizations most likely to be affected by the final rule are: (1) school bus manufacturers, (2) dealers and distributors of school buses, and (3) public/ private school bus transportation owners/operators (e.g., state/local school districts).

The school bus operators will be the group most affected by the subject amendments to FMVSS No. 221 because of increased school bus purchase prices and potential increased maintenance costs. Despite the fact that most school bus jurisdictions are under tight budget constraints, the increase in purchase price is not expected to significantly influence the demand for new school bus products. The sales weighted average consumer cost increase of $222 for large buses is 0.49 percent ($222/$45,280) of the price of a 1990 model year 66 passenger school bus with an approximate $45,280 retail purchase price.[1,2,3] For a small school bus, the estimated incremental consumer cost of $343 per affected vehicle represents 1.20 percent ($343/$28,300) of the retail price of a new $28,300 small school bus.

The Small Business Administration (SBA) defines a bus manufacturer with less than 500 employees as a small business (13 CFR Part 12 1 Revised). Using this definition, the agency believes that many of the 14 school bus manufacturers will qualify as a small businesses. All of the small bus manufacturers apparently offer FMVSS No. 221 body joint strength at an option, and 22 states are already purchasing small buses with FMVSS No. 221 joint strength. Therefore, no new manufacturing techniques or tooling will be required to comply. Costs, as a percentage of the total school bus manufacturing cost, will not increase significantly. As discussed further below, any impact on total school bus sales should be negligible. On balance, the agency anticipates no measurable impact on school bus manufacturers' revenue levels, profitability, or employment. The SBA defines a Motor Vehicle Retailer (SIC 5511)

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[1] Final Regulatory Evaluation, Wheelchair Securement/Occupant Restraint Devices, Amendment to FMVSS No. 222, School Bus Seating and Crash Protection, September, 1992, NHTSA, Office of Regulatory Analysis, Plans and Policy, Docket 90-05-N04.

[2] Final Regulatory Evaluation, Bus Emergency Exits and Window Retention and Release, Amendment to FMVSS No. 217, October 1992, NHTSA, Office of Regulatory Analysis, Plans and Policy, Docket No. 88-21-N03-001.

[3] Preliminary Regulatory Evaluation, Amendments to School Bus Body Joint Strength, FMVSS No. 221, February, 1991, National Highway Traffic Safety Administration, Plans and Policy, Office of Regulatory Analysis, Docket No. 73-34-N10-001.

with less than $11.5 million in receipts as a small business. There are approximately 465 school bus dealers and distributors in the United States. During the last 8 years, about 35,000 (avg.) school buses were sold annually, or about 75 buses per dealer on average. In order to reach $11.5 million in sales receipts, the average dealer would have to sell about 270 school buses annually assuming a cost of $42,563 per bus. (The sales weighted average cost of a small and large school bus. See the Appendix for calculation.) Thus, most school bus dealers probably are small businesses. It is anticipated that the average increase in the retail price of a new small and large school bus, estimated to 1.20 and 0.49 percent, respectively, will not have a significant effect on school bus sales.

It is difficult to determine what impact the price increase would have on school bus purchases by states/local school districts. There is a given demand for school buses to transport children and no comparable alternative. As a "worst case," with many states and school districts operating on fixed budgets for school bus purchases, a 1.20 percent price increase for small buses, and 0.49 percent price increase for large buses, may result in a similar reduction in new school bus sales, or the school districts may offset the price increases by purchasing school buses with less optional equipment (such as luggage racks, extra batteries, and upgraded interiors).

VIII. CUMULATIVE IMPACT OF RECENT RULEMAKING ACTIVITIES ON SCHOOL BUSES

Section 1(b)11 of Executive order 12866 Regulatory Planning and Review requires the agencies to take into account to the extent practicable "..the costs of cumulative regulation." To adhere to this requirement, the agency has decided to examine both costs and benefits of the regulations affecting school buses in MY 1990 or later. There are a number of recent school bus rules which have a direct impact on the consumer costs of school buses; upgrade of emergency exits (FMVSS No. 217), upgrade mirror systems (FMVSS No. 111), incorporate stop arms (FMVSS No. 131), incorporate wheelchair securements (FMVSS No. 222), stopping distance and stability control requirements (e.g., anti-lock brake system (ABS) requirements) (FMVSS No. 121) and implement automatic brake adjusters (FMVSS No. 121). The accumulated incremental consumer cost per school bus since 1990, including the subject rule, is estimated to be about $2,055 to $2,075 per bus.

Table VIII-1
Recent Rules since 1990 and Consumer Cost (1996$) per School Bus and Benefits

FMVSS Number & Issuance Date	Name of Rule	Average Cost per Vehicle and Benefits
131 (11/90)	Stop Signal Arms	$102 0-3 lives saved annually 0-13 1 injuries prevented annually 19-35 M illegal passes prevented/year
222 (5/91)	Wheelchair Securements	$ 82 Benefits not quantified
111 (5/92)	Upgrade Mirror Systems	$28 Benefits not quantified
217 (11/92)	Upgrade Emergency Exits	$614 Benefits not quantified
121 (2/95)	Stopping Distance (SD) Stability Control (SC)	$39-58 Air braked $2-5 Hydraulic braked SD 0 lives saved SD 4 injuries prevented $720 SC 16 - 25 lives saved SC 790 - 1,362 injuries prevented
121 (2/95)	Automatic Brake Adjusters	$230 1 life saved annually 15 injuries prevented annually $1.083 Million PDO savings
49CFR 571.3 (5/95)	Modified dsp definition for school buses. 1 WC = 4 dsp*	$-0- Administrative only
201 (6/96)	Exempted school buses from 15 mph interior static padding head protection requirements.	These costs were never incurred by industry, therefore, no savings is accrued by exempting school buses from the rule.
221 (SUBJECT RULE 11/98)	Upgrade MAP/Body Joint Strength	$241 5-36 AIS 1-3 laceration-type injuries prevented annually and 1-10 AIS 3 fracture-type injuries prevented annually.

Cumulative Cost		\$2,055-\$2,075

* dsp = designated seating position

For calculating the benefits (lives saved, injuries reduced and PDO savings) in Table VIII-1 for FMVSS 105/121 rules [e.g., automatic brake adjuster (ABA) and stopping distance (SD)/stability-control (ABS)], large school buses were estimated to 4.97 % of the Class 5-8 truck chassis affected. Benefits were assumed to be proportional to this market share. The proportion of affected single-unit trucks including school bus chassis subject to FMVSS 105/121 are 248,300/591,900 or 41.95 percent. Large school bus chassis types B+C+D equal 84.07 percent of 35,000 units or 29,425 units. The total medium truck chassis (including school bus chassis) subject to FMVSS 105/121 rules is 248,300 units. The portion of school bus chassis is 29,425/248,300 = 11.85 percent. Therefore, the percentage of school bus chassis compared to all chassis (Class 5-8) is 4.97 percent [(.1185) X (.4195) X 100% = 4.97 percent].

IX. SUMMARY

In the subject final rule, NHTSA has decided to: (1) redefine MAPs which are exempt from the provisions of FMVSS No. 221; (2) extend the MAP and joint strength requirements of FMVSS No. 221 to small, Type A school buses; and (3) improve the "objectivity" of the body joint strength standard.

Under the final rule, MAPs outside the occupant compartment space would be excluded from the requirements of the final rule, and MAPs inside the occupant compartment space would be required to meet the 60 percent joint strength requirement of the rule, unless certain opening size/access frequency restrictions are met. For an MAP within the occupant compartment space to be exempt; (1) the aperture opening necessary to access a serviceable component must not exceed 12 in. (30 cm) when measured across opposite edges and in "any" direction and (2) the serviceable component must require a maintenance frequency of at least once a year. Compared to the NPRM, the establishment of a maximum aperture opening independent of the perimeter of the serviceable component, improves "objectivity" by: (1) eliminating the measurement of "projected areas" of serviceable components and (2) eliminating the definition of vertical or horizontal aspects of a serviceable component. Overall, this will enhance enforceability as only the aperture opening, regardless of its orientation, need be measured.

Manufacturers have two options for complying; (a) redesigning school bus MAP aperture openings (such as by using smaller apertures at serviceable components and connecting them with electrical conduit to facilitate removal and replacement of wires), and/or (b) adding extra fasteners such as screws to existing MAPs. The final rule also extends the requirements of FMVSS No. 221 to small, Type A school buses < = 10,000 lbs. (4,536 Kg.) GVWR.

In addition to the above, a number of changes have been made to improve the "objectivity" of FMVSS No. 22 1 including: (1) clarifying the definition of exempted and unexempted MAPs and adopting the definition of "passenger compartment space," (2) reaffirming the applicability of the standard to floor joint strength and clarifying that the standard applies to each possible 8" segment (rather than just representative segments); (3) exempting non-metallic (or non-structural) parts/components such as trim, decorative parts, floor coverings/molding, ventilation panels; (4) exempting front and rear interior engine access covers for small and large buses; (5) defining the method of determining tensile strength; and (6) quantifying the term "approximately perpendicular."

The sales weighted average consumer cost (incremental cost increase) to eliminate/redesign MAPs in large school buses is estimated to be $222 per unit and the sales weighted cost to upgrade small school buses to comply with the joint strength provisions of FMVSS No. 221 and new MAP requirements is estimated to be $343 per affected vehicle. The total consumer cost is estimated to be $8.440M. Approximately 5-36 AIS 1-3 laceration-type injuries would be forestalled annually if MAPs are redesigned on large and small school buses. About 1-10 AIS-3 fracture-type injuries would be forestalled annually if body joint strength in small buses is upgraded. Overall, 6-46 minor-to-serious injuries would be reduced or eliminated annually. The impact on small business entities is estimated to be negligible.

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2.) Estimates from the National Center for Statistics and Analysis (NCSA) and the agency's report for Congressman Luken entitled "Report on School Bus Safety", Office of Vehicle Safety Standards, NHTSA/DOT, October, 1988.

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4.) Collision of Isle of Wight County, Virginia School Bus with Chesapeake and Ohio Railway Company Freight Train, State Route 615 near Carrsville, Virginia, April 12, 1984, Highway Accident Report, National Transportation Safety Board, Washington, D.C. 20594, NTSB/HAR-85/02, PB85-916202.

5.) School Bus Rollover, State Route 88 near Jefferson, North Carolina, March 13, 1985, Highway Accident Report, National Transportation Safety Board, Washington, D.C., 20594, NTSB/HAR-85/05, PB85-916206.

6.) Valley Supply Company Truck Towing Farm Plow/Anchor Motor Freight Inc. Car-Carrier Truck/New York -State Association for Retarded Children Bus Collision and Fire, State Rt. 8, Near Holmesville, NY, April 5, 1983, Highway Accident Report, National Transportation Safety Board, Washington, DC 20594, NTSB/HAR-84-01 (non-school bus)

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13.) Dynamic impact test of a School Bus with a 10,000 Pound Moving barrier with a Contoured Front End, 45 Degrees Impact, (65 passenger -1989 Thomas School Bus @ 30 Mph) Mobility Systems and Equipment Company, 9920 La Cienga Boulevard Suite 708, Inglewood, CA 90301, Final Report, August 1989, Docket No. 73-34-N08-044.)

14.) 73-34-N08-029, Thomas Built Buses, L.P., Letter dated October 13, 1987 to the Docket regarding a proposed dynamic moving barrier crash test for school bus integrity tests.

15.) S571.221 Standard 221; School Bus Body Joint Strength, 49 CFR Ch. V (10/1/86 Edition).

16.) S571.222 Standard 222; School Bus Passenger Seating and Crash Protection, 49 CFR Parts 400 to 999, Revised October 1, 1991.

17.) Final Regulatory Evaluation, Amendment to FMVSS No. 221 School Bus Body Strength, Elimination of Exemption for Most Maintenance Access Panels, July 1983, NHTSA, Office of Planning and Analysis.

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21.) Final Regulatory Evaluation, Wheelchair Securement/Occupant Restraint Devices, Amendment to FMVSS No. 222, School Bus Seating and Crash Protection, September, 1992, Office of Regulatory Analysis, Plans and Policy, NHTSA.

22.) Preliminary Cost Analysis, Part 571.3. Definition of Designated Seating Position for Wheelchair Securement Position, September 1993, Office of Regulatory Analysis, Plans and Policy, NHTSA.

23.) Final Regulatory Evaluation, FMVSS No. 111, Performance Requirements for School Bus Mirror Systems, May 1992, Office of Regulatory Analysis, Plans and Policy, NHTSA.

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26.) Final Regulatory Evaluation, Amendment to FMVSS Nos. 105 and 121, Automatic Brake Adjusters (ABA) and Adjustment Indicators for Medium and Heavy Duty Vehicles, September 1992, Office of Regulatory Analysis, Plans and Policy, NHTSA.

APPENDIX

1. Calculation of the Cost Per Affected Vehicle (CPAV) for a Small, Type-A School Bus

2. Calculation of the Sales-Weighted Average Consumer Cost (SWACC) of a Large Type B,C,D School Bus

3. Calculation of the Sales-Weighted Average Consumer Cost (SWACC) of a Large/Small School Bus

4. Calculation of the Sales-Weighted Cost of a New Large/Small School Bus

5. Calculation of the In-use Population of Small, Type-A School Buses

6. List of School Bus Body Types by Manufacturer

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1. Calculate the Cost per Affected Vehicle (CPAV) for a small, Type-A school bus complying with the subject final rule.

   Referring to Table V-1, approximately 16 percent of all the 35,000 buses sold annually are small. The number of small buses sold each year is approximately 5,576 (.1593 X 35,000). Per the subject final rulemaking, 100 percent (5,576 units) will have to change their MAP designs at $74 per unit and 65 percent (100%-35%) or 3,624 units will need to have 221 joint strength incorporated at $414 per unit. Therefore, the cost per affected vehicle (CPAV) is as follows:

   CPAV for Type A Vehicle = [((5,576 X $74) + (3,624 X $414))/(5,676)]

   = ($412,624 + $1,500,336)/5,576

   = $1,912,960/5,576

   = $343.00 per unit

2. Calculate the Sales-Weighted Average Consumer Cost (SWACC) of a Large, Type B+C+D school bus which would comply with the subject final rule.
   As shown in Table V-1, Type B (10-20 capacity), Type C (24-77 capacity), and Type D (78+ capacity) comprise 84.07 percent of total sales. Average annual sales total 34,630 (without rounding) and are estimated to be 603 (1.74%), 20,896 (60.34%), and 7,615 (21.99%), respectively, and employing the incremental consumer cost data from Blue Bird \$147 (35 passenger), \$209 (66 capacity) and \$270 (84 capacity) and the assumption of \$74 for 10-20 capacity yields:

   SWACC Type B,C, D = [((.0174 X \$74) +(.6034 X \$209) + (.2199 X \$270))/(.8407)]

   = [(\$1.29 + \$126.11 + \$59.37)/(.8407)]

   = \$222.16 per unit

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3. Calculate the Sales-Weighted Average Consumer Cost (SWACC) of a Large/Small (Type A+B+C+D) combined school bus which would comply with the subject final rule.

   Employing the percentage distribution by body type directly from Table V-1, and the CPAV for a Type-A school bus of \$343, yields the following:

   SWCC Type A+B+C+D = [(.1593 X \$343) + (.0174 X \$74) + (.6034 X \$209) + (.2199 X \$270)/1.000

   = \$54.64 + \$1.28 + \$12.60 + \$126.11 + \$59.37

   = \$241.40

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4. Given the current cost of small and large school buses (without the subject countermeasures), calculate the Sales-Weighted Average Consumer Cost (SWACC). Employing Table V-1, it is estimated that 16 percent of the new school buses cost on the average \$28,300/unit and the 84 percent of the school buses cost \$45,280/unit. Small school buses cost in the range of \$22,640-\$33,960 or \$28,300 average.

SWACC = [(.16 X \$28,300) + (.84 X \$45,280)] = \$42,563

Therefore, from calculation #3 above, \$241.40 divided by \$40,865 equals a 0.591 percent increase across <u>all</u> buses.

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5. The calculation of the minimum/maximum number of small school buses in-use is based on the assumption that the in-use population is proportional to the annual market share or sales (e.g., Table V-1 shows 16 percent of the annual school bus sales are small, Type-A buses, therefore, it is assumed that 16 percent of the total population is small buses.) This is the basis for the lower boundary. The upper boundary of 25 percent comes from a 1993 School Bus Fleet study December/January, an article entitled - "100 School Bus Fleets," which indicated that about 20 percent of public school buses are small, whereas 30 percent of contractor school buses are small [(20% +30%)/2] = 25 percent). The estimated total number of buses is 410,673 comes from the School Bus Fleet, 1993 Fact Book Issue, January 1996, Statistics: School Transportation 1993-94 School year.

Minimum Number Type-A In-use = .16 X 410,673 = 65,798
Maximum Number Type-A In-Use = .25 X 410,673 = 102,668

FRACTIONAL DISTRIBUTION OF MAIS WITHIN CATEGORIES OF THE KABCO SCALE
(ESTIMATES USED BY P&P)

MAIS	K-Injury	A-Injury	B-injury	C-injury	No Injury	severity Unknown	Unknown
Survivors							
AIS=0	0.01276	0.01508	0.04937	0.19917	0.92342	0.07494	0.81552
AIS=1	0.01650	0.48917	0.79208	0.71722	0.07421	0.70313	0.15986
AIS=2	0.00676	0.27769	0.12484	0.06760	0.00208	0.15648	0.01618
AIS=3	0.00135	0.16623	0.03008	0.01509	0.00028	0.04327	0.00780
AIS=4	0.00224	0.32891	0.00267	0.00064	0.00001	0.01706	0.00020
AIS=5	0.00000	0.01752	0.00069	0.00018	0.00000	0.00133	0.00044
Fatalities	0.96039	0.00540	0.00027	0.00010	0.00000	0.00379	0.00000
Total	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

ANNUALIZED ESTIMATES OF KABCO AMONG SCHOOL BUS PASSENGERS
(1988-1996 GES DATA)

	K-Injury	A-Injury	B-injury	C-injury	No Injury	Severity Unknown	Unknown
Total	1	901	1,655	5,034	22,886	207	493

ESTIMATED ANNUALIZED ESTIMATES OF MAIS AMONG SCHOOL BUS PASSENGERS
(1988-1996 GES DATA PLUS P&P KABCO-MAIS CONVERSIONS)

MAIS	K-Injury	A-Injury	B-injury	C-injury	No Injury	Severity Unknown	Unknown	Total
Survivors								
AIS=0	0	14	82	1,003	21,133	16	402	22,649
AIS=1	0	441	1,311	3,610	1,698	146	79	7,285
AIS=2	0	250	207	340	48	32	8	885
AIS=3	0	150	50	76	6	9	4	295
AIS=4	0	26	4	3	0	4	0	38
AIS=5	0	16	1	1	0	0	0	18
Fatalities	1	5	0	1	0	1	0	8
Total	1	901	1,655	5,034	22,886	207	493	31,177
AIS 1-6	1	887	1,573	4,031	1,753	191	91	8,521
AIS 2-6	1	447	262	421	54	46	12	1,243
AIS 3-6	1	196	56	81	7	14	4	358

Number injured	
Identified by KABCO	7,798
AIS 1-6	8,521
AIS 2-6	1,243
AIS 3-6	358

MOTOR VEHICLE TRAFFIC CRASHES INVOLVING SCHOOL BUSES WHERE THERE WAS AN
1) A OR K BUS OCCUPANT INJURY OR, 2) THE BUS WAS TOWED OR, 3) THE BUS OVERTURNED
SELECTION CRITERIA USED - [redacted] (APPROX. NTSB)
1988-1996 GES (UNWEIGHTED/WEIGHTED)

	Unueighted	Weighted
Calendar Year		
1988	9	833
1989	9	1,101
1990	431	2,378
1991	37	1,184
1992	47	2,097
1993	51	1,340
1994	391	2,039
1995	18	1,018
1996	30	2,159
Total	283	14,147

MOTOR VEHICLE TRAFFIC CRASHES INVOLVING SCHOOL BUSES WHERE THERE WAS AN
1) A OR K BUS OCCUPANT INJURY OR 2) THE BUS OVERTURNED (MHE OR ROLLOVER)
SELECTION CRITERIA USED - [redacted] (APPROX. NTSB)
1988-1996 GES (UNWEIGHTED/WEIGHTED)

	Unweighted	Weighted
Calendar Year		
1988	3	200
1989	'I	33
1990	7	644
199,	9	150
1992	9	'307
1993	13	327
1994	7	303
1995	4	84
1996	5	167
Total	58	2.216

MOTOR VEHICLE TRAFFIC CRASHES INVOLVING SCHOOL BUSES
1988-1996 GES (UNWEIGHTED/WEIGHTED)

	Unweighted	Weighted
Calendar Year		
1988	105	17,466
1989	121	22,545
1990	2151	27,884
1991	218	23.917
1992	212	21,814
1993	283)	27,806
1994	203	24,093
1995	184	28,773
1996	189	26.711
Total	1,730	221,009

Motor Vehicle Traffic Crashes Involving School Buses
Select Criteria Used (NTSB)
GES Files 1988-1996

	TYPE				
	Occ Injured (A or K Injury)	Bus Towed	Bus Over-Turned (MHE or Rollover)	Other Bus Crash	Total
YEAR					
1988	•	1,000	*	17,000	17,000
1989	*	1,000	*	21,000	23,000
1990	1,000	1,000	*	26,000	28,000
1991	*	1,000	*	23,000	24,000
1992	*	1,000	*	20,000	22,000
1993	*	1,000	*	27,000	28,000
1994	*	2,000	*	22,000	24,000
1995	*	1,000	*	28,000	29,000
1996	[illegible]	1,000	*	25,000	27,000
Total	2,000	10,000	1,000	210,000	221,000

* Sample size was too small to produce a meaningful estimate, The estimate was less than 500.

Sampling Errors for Table II-2
(One approximate standard error)

	Fatal Crash	Injury Crash	PDO Crash	Total
FHE - Collision w/ MVIT		1,100	2,420	2,870
FHE - Collision w/ Fixed Object				
FHE - Collision w/ Object Not Fixed		500	1.100	I.100
Non-collision				
Total		1,100	2.690	3,230

Sampling Errors for Table II-3
(One approximate standard error)

	Fatality	Injured	Total
Bus Occupant		I.500	1.500
Others	-	-	-
Total	-	1,500	1,600

FHF. = First Harmful Event
MVIT = Motor Vehicle in Transport

School Bus Type Designations

During the 9th National Standards Conference on student transportation held in 1980, the classifications for school buses changed from Type I and Type II to Type A, Type B, Type C and Type D. That classification applies to vehicles manufactured after 1980. At the 10th National Standards Conference in 1985 a federal vehicle classification was adopted by the school bus industry for vehicles with less than 10 passenger capacity, including the driver. That classification, Multi-Purpose Vehicle (MPV), includes vans and other vehicles that cannot be certified as a school bus. This survey does not include a separate category for MPV vehicles because those vehicles are typically manufactured by automobile manufacturers.

COMPANY	 TYPE A	 TYPE B	 TYPE C	 TYPE D
AmTran				
Ward Volunteer			•	
Ward Vanguard	•			
Ward Senator Fwr'd Control				•
Genesis Fwr'd Control				•
Blue Bird Body Co.				
Micro Bird	• (Dual)			
Mini Bird		•		
Conventional			•	
TC/2000				•
TC/2000 Rear Engine				•
All American Rear Engine				•
All American Frw'd Control				•
Carpenter Mfg.				
Classmate	• (Dual)			
Cadet		•		
Classic			•	
Counselor				•
Counselor Rear Engine				•
The Coach Rear Engine				•
Collins Bus Corp.				
Super Bantam	•			
Bantam	•			
Gillig Corp.				
Advanced Design Bus				•
Girardin				
Minibus	•			
GMC				
Vandura	•			

School Bus Type Designations

CCMPANV	 TYPE A	 TYPE B	 TYPE C	 TYPE D
Mid Bus				
Superior	•			
Busette	• (Dual)			
Mid Bus Guide	• (Dual)			
Superior Coach Intl				
Partner	•			
TAM USA				
252A121				•
Thomas **Built Buses**				
Minotour	• (Single) • (Dual)			
Mighty Mite		•		
Vista		•		
Conventional			•	
Saf-T-Liner				•
MVP				•
Westcoast-ER				•
Ail Star				•
STURICORP.				
SturdiVan	•			
Super-SturdiVan	•			
SturdiBus	• (Dual)			
Van-Con Inc.				
16-20 Passenger	•			

***Type A** school bus is a conversion or body constructed upon a van-type, compact truck or a front section vehicle, with a gross vehicle rating of 10,000 pounds or less, designed for carrying more than 10 persons.*

Type B school bus is a conversion or body constructed and installed upon a van or front section vehicle chassis, or stripped chassis, with a gross vehicle weight rating of more than 10,000 pounds, designed for carrying more than 10 persons. Part of the engine is beneath and/or behind the windshield and beside the driver's seat. The entrance door is behind the front wheels.

Type C school bus is a body installed upon a flat-back cowl chassis with a gross vehicle weight rating of more than 10,000 pounds, designed for carrying more than 10 persons. The engine is in front of the windshield, *and the entrance door is behind the front wheels.*

Type D school bus is a body installed upon a chassis, with the engine mounted in the front, midship, or rear, with a gross vehicle weight rating of more than 10,000 pounds, designed to carry more than 10 persons. The engine may be behind the windshield and beside the driver's seat; it may be at the rear of the bus, behind the rear wheels; or midship between the front and rear axles. *The entrance door is ahead of the front wheels.*

MPV is a vehicle with less than 10 passenger capacity including the driver that cannot be certified as a school bus. The MPV is a federal vehicle classification that was adopted by the school bus industry at the 10th National Standards Conference in 1985.